APPENDIX F

MITIGATION AND MONITORING PLAN

DOS POBRES/SAN JUAN PROJECT

CLEAN WATER ACT SECTION 404 MITIGATION AND MONITORING PLAN

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1. INTRODUCTION

This document summarizes the plan of Phelps Dodge Safford, Inc. (PDSI) to mitigate for potential impacts to waters of the United States[1] (also referred to as jurisdictional waters in this document) that would result from development of the proposed Dos Pobres/San Juan Project (the Project).

This Clean Water Act (CWA) Section 404 Mitigation and Monitoring Plan (the Plan) is presented in three sections: this Introduction, which includes a brief description of the proposed project and project history; Section 2, which summarizes the potential impacts to jurisdictional waters and the proposed mitigation for those impacts; and Section 3, which deals with measures to be taken to mitigate for potential impact from groundwater pumping and surface water interception at the project to the Gila River.

1.1. PROJECT DESCRIPTION

The Project is located in Graham County, north of the town of Safford, Arizona (Figure 1). The Project is an integrated copper mining operation that includes the development of two open-pits, one solution extraction/electrowinning (SX/EW) processing facility, and shared infrastructure and support facilities. The proposed Dos Pobres and San Juan mine pits are located approximately 7 to 8 miles north of the Gila River near Safford, Arizona, at an elevation of approximately 4,100 feet above mean sea level (amsl) in the foothills of the Gila Mountains. The ridge line of the Gila Mountains, at its closest point to the mine pits, rises to an elevation of approximately 6,050 ft amsl at Weber Peak approximately 2.5 and 1.5 miles east of the Dos Pobres and San Juan pits, respectively.

Based upon the current Plan of Operations, the Project will produce approximately 2.9 billion pounds of salable copper over the Project's estimated 16-year production life. Project production will include the mining of 626 million tons of oxide and sulfide leach ore, and 385 million tons of lower-grade and unmineralized material generally referred to as development rock. Total mineable material amounts to 1.01 billion tons, resulting in a 0.6:1.0 non-ore to ore ratio. Construction of the SX/EW plant, crushing and material handling system, and associated support facilities will require approximately 15 months to complete and will start after completion of the Project's environmental permitting requirements and final authorization by the Board of Directors of Phelps Dodge Corporation. Approximately 3,360 acres of land will be directly impacted by proposed mine features. These impacts will occur on a combination of private and publicly owned lands. Should the land exchange alternative being considered by the Bureau of Land Management (BLM) in their Dos Pobres/San Juan Project Environmental Impact Statement (EIS) be selected, the proposed action will occur entirely on privately held lands.

[1] Waters of the United States, as used in the context of this document, refers to areas of the Corps' jurisdiction, as defined at 33 CFR, Part 328.3(a)(1-7). It does not refer to actual water that may from time to time be transported by the normally ephemeral washes.

1.2. PROJECT HISTORY AND BACKGROUND

In 1994, PDSI proposed the Safford Land Exchange with the BLM for the purpose of consolidating PDSI's property holdings in the Safford Mining District. Through the proposed land exchange, PDSI would acquire public lands (referred to as the Selected Lands) within and adjacent to its existing private property in the District in exchange for other lands (referred to as the Offered Lands) in Arizona currently owned by Phelps Dodge Corporation (PDC). Initial scoping for the Safford Land Exchange occurred during the fall of 1994.

During this process, two separate events occurred: PDSI was made aware of the U.S. Army Corps of Engineers' (COE) likely requirement of an EIS as a component of the COE's public interest review under Section 404 of the CWA, and PDSI's development of the mine plan progressed such that they were able to define a specific project and development schedule. In response to these events, PDC submitted a Mining Plan of Operations (MPO) to the BLM in May 1996 pursuant to the General Mining Law of 1872 and its implementing regulations at 43 Code of Federal Regulations (CFR) Section 3800, Subpart 3809. The MPO describes the Project.

The BLM is evaluating the MPO as required by the procedures of the National Environmental Policy Act (NEPA) and BLM implementing regulations, and they published a Draft EIS in 1998. Currently, the COE and the U.S. Environmental Protection Agency (EPA) are cooperating with the BLM pursuant to applicable agency and Council on Environmental Quality guidelines. Within the Draft EIS, the BLM also published its evaluation of the proposed land exchange as an alternative to the MPO. In the Draft EIS, the BLM identified the proposed land exchange as the preferred alternative. The MPO alternatives continue to be evaluated by the COE and the EPA as required for their permit review procedures.

After coordination with the COE and U.S. Fish & Wildlife Service (USFWS), elements of the habitat mitigation plan were initiated in Spring 1999 due to the time-sensitive nature of the proposed mitigation at the Pima Enhancement Site. This effort did not require CWA section 404 permit or other agency authorization. The COE made it very clear to the applicant that implementation of habitat enhancement efforts would not affect the COE's permit decision but that the mitigation credits derived from this effort would be available for the project in the event the COE issues a Section 404 permit.

PDSI revised the MPO in August of 2001. Revisions to the proposed plan are focused on processing technologies and have not resulted in substantial changes to the project footprint, and no anticipated changes in the direct impacts to waters of the United States. Proposed changes to the Plan are discussed in detail in the MPO. These changes include the addition of ore agglomeration and conveying/stacking systems that significantly reduce truck haulage requirements. The utilization of an agglomeration system during the processing of crushed ore also allows for substantially reduced process solution flow-rates and make up water requirements. Because of the reductions in haul truck requirements, the amount of water needed for dust suppression on haul roads has been reduced. These proposed changes have resulted in 20 percent reductions in the projected average annual water consumption rate, a 25 percent reduction in projected sulfuric acid consumption, and reduced air emissions.

1.3. JURISDICTIONAL IMPACTS

1.3.1. Distribution and Functions of Waters of the United States

Between the proposed mine site and the Gila River is a broad, gently sloping plain. Vegetation in the uplands of this area is characteristic of Sonoran desertscrub habitats and is dominated by broad creosotebush flats. As the project area increases in elevation towards the Gila Mountains, upland vegetation communities gradually transition to semidesert grassland habitat types. Drainage patterns in the project area are characterized in many places by braided channel systems or sheet flow, and in other areas drainage patterns are dendritic. All of the drainages in the project area are ephemeral washes and the primary drainages report to the Gila River just north of Safford. The primary drainages within the project area, from east to west, are Wilson, Peterson, Cottonwood, Talley, Watson, and Coyote washes. In the vicinity of the project area, there are three springs (Cottonwood, Hackberry, and Bryce), and one small seep referred to as DP Seep. The springs are outside of the footprints of disturbance for the proposed project, while the DP Seep is within the footprint of the proposed Dos Pobres pit.

Table 1 summarizes vegetation characteristics within the project area. Xeroriparian vegetation in the project area is generally open and patchily distributed. As is typical with xeroriparian vegetation, most of the plant species present also occur in upland habitats, though in xeroriparian habitats they typically occur at higher densities and are generally larger. Total vegetation volume (TVV) in washes in the project area typically ranges from 0.25 to 0.65 m^3/m^2 and averages approximately 0.45 m^3/m^2. In comparison, upland habitats on this property have vegetation volume from 0.1 to 0.33 m^3/m^2 and averaged approximately 0.24 m^3/m^2.[2] Xeroriparian areas have been qualitatively assigned to three categories based upon apparent channel width identified from available aerial photography. Category 1, xeroriparian areas (the widest channels), supported the lowest vegetation volumes (mean = 0.31 m^3/m^2). Category 2 (intermediate channel widths) and Category 3 (the narrowest channel widths) supported nearly identical amounts of vegetation (average values are 0.46 m^3/m^2 and 0.47 m^3/m^2, respectively). Creosotebush, not normally considered a riparian plant, comprised 30.4 percent, 23.0 percent, and 33.9 percent of the TVV in the Category 1, 2, and 3 xeroriparian areas, respectively. Other dominant plant species in the xeroriparian habitats that occur within the project area included catclaw acacia, mesquite, blue paloverde, whitethorn acacia, and burroweed.

[2] For comparison, well vegetated, upland Sonoran Desertscrub habitat in Northwest Tucson will typically have TVV slightly greater than 0.5 m^3/m^2; Mesquite Bosques typically exceed 1.5 m^3/m^2; and mature Cottonwood/Willow riparian habitats typically exceed 3.0 m^3/m^2.

Table 1. Dominant Plant Species Within Xeroriparian Habitats and Adjacent Upland Habitats in the Project Area

	Xeroriparian Habitat			
	Category 1	**Category 2**	**Category 3**	**Upland**
No. Transects	21	61	92	36
No. Points	702	894	629	720
No. Washes or Areas	5	11	13	9
Mean Width (m)	66.8	29.4	13.6	Na
Mean Vegetation Volume	0.31	0.46	0.47	0.24
	Percent Dominance			
Creosotebush	30.4%	23.0%	33.9%	63.3%
Mesquite	11.3%	22.0%	4.8%	1.2%
Catclaw Acacia	14.3%	21.4%	10.1%	0.7%
Whitethorn Acacia	5.1%	4.4%	20.7%	0.6%
Blue Paloverde	8.7%	6.5%	10.1%	0.8%
Burroweed	14.1%	4.1%	2.8%	0.6%
Desert Broom	6.7%	2.9%	0.6%	0.0%
Snake Weed	1.3%	2.3%	3.2%	3.7%
Prickly Pear	0.0%	0.0%	< 0.1%	5.6%
Perennial Grasses	1.0%	4.0%	7.1%	16.5%
All Other Species	7.1%	9.4%	6.7%	7.0%

Wetlands located at Cottonwood and Bryce springs will not be directly impacted by the proposed action and their position, relative to geologic faults in the project area, suggest that they would not be impacted by groundwater pumping at the mine (R. MacNish, personal communication, March 1998). DP Seep, which lies within the footprint of the proposed Dos Pobres pit, would be impacted. There are no jurisdictional wetlands associated with this seep. Other springs near the project area include Hackberry and Walnut springs. These springs will not be directly impacted by the proposed project and do not have jurisdictional wetlands associated with their surface-water discharge.

An evaluation of the functions generally attributed to waters of the United States and their applicability to waters impacted by this project is provided in Table 2.

Table 2. Functions Evaluation of Jurisdictional Waters of the United Sates at the Dos Pobres/San Juan Project

Energy/nutrient cycling — The drainages that will be impacted by the proposed Dos Pobres/San Juan project are ephemeral and do not contain aquatic resources that would be dependent upon allochthonous inputs to establish and maintain the energy and nutrient dynamics of these systems. Existing downstream energy inputs from the project area to the Gila River are not expected to be significant in light of the size of the Gila River watershed relative to the nature of impacts associated with this project. Desert streams depend more on nutrient inputs from surrounding land than from upstream inputs. Even this input is small compared to mesic situations. Due to the general lack of retention devices in desert streams (e.g., snags) upstream materials tend to get washed far downstream or caught in the adjacent floodplain (Fisher 1986, p. 124). The nature of xeroriparian habitats associated with jurisdictional waters at and immediately downstream of the project site are such that they are not expected to be dependent upon energy or nutrient inputs from the project area. Almost all of the species found within these habitats are also found in adjacent uplands, and many of the dominant species are able to fix nitrogen. These systems are not expected to provide significant nutrient cycling and energy functions to adjacent upland or downstream habitats.

Habitat function (nesting, feeding, spawning, rearing and resting sites for aquatic or land species) — There is perennial water to support aquatic species or habitats within the jurisdictional drainages directly impacted by the proposed facilities or indirectly impacted by diversion of surface water flows for stormwater management activities. Habitat functions along these jurisdictional drainages are provided by the xeroriparian habitats adjacent to jurisdictional waters that have been described in detail elsewhere. Within the project area, these habitats support a variety of common, terrestrial wildlife species, many of whom utilize both xeroriparian and adjacent upland habitats. There will be direct impacts to these functions in areas subject to excavation and fill activities. There is potential for some impact to habitat functions of drainages below the project site from surface water diversions. This impact would be a direct result of potential reductions in vegetation biomass and structure and species composition as a consequence of reduced water availability. These impacts are expected to be minor – we currently hypothesize that these habitats are maintained by the surface runoff from adjacent uplands and are not dependent upon the ephemeral flows originating in the upper watershed that occasionally will generate discharge to the Gila River. As a consequence, impacts to downstream habitat functions, if any, are expected to be minor.

Hydrologic functions - stormwater transport — This is a function of the waters of United States impacted by the Dos Pobres/San Juan Project. The drainages impacted by the proposed project collect and transport stormwater; they are normally dry except during and immediately after local or regional precipitation events. Potential impacts of the adjacent stormwater drainage systems that convey stormwater to the Gila River from areas upgradient of the mine will be mitigated by construction of proposed stormwater diversion facilities. Within the mine facilities, stormwater will be managed to ensure that there are no discharges from the mine. Changes in stormwater transport are summarized in the EIS and described in detail in the stormwater management master plan for the project.

Hydrologic functions - sediment transport — This is a function of waters of the United States impacted by the Dos Pobres/San Juan Project. The natural drainage system within the project area collects and transports sediment during the periods of time when water flows in the channel (during and immediately following precipitation events). Following construction of the proposed stormwater diversion system and other mine-related facilities for the Dos Pobres/San Juan Project, sediment transport of the existing drainage system will be impacted. Impacts include increased scour potential at the discharge points of the diversion channels and removal of potential bed load material as a result of construction of the diversions and other stormwater management facilities. Impacts from alteration of sediment transport processes were considered in the design of the stormwater diversion and adverse impacts from excessive channel degradation were included in the assessment of direct impacts to jurisdictional waters. Changes in the sediment transport characteristics associated with project development have been summarized in the EIS and are presented in detail in the stormwater management master plan for the project. Downstream channels (de-watered by diversion construction or receiving additional flow from diversions) are expected to re-establish a dynamic equilibrium for sediment transport and further mitigation of this function is not warranted.

Table 2. Functions Evaluation of Jurisdictional Waters of the United Sates at the Dos Pobres/San Juan Project
Protection of uplands from erosion or storm drainage — This functional value for waters is generally found in shoreline or coastal wetland systems or larger riverine systems. These systems are not present in the project area and waters of the United States in the project area do not provide this function.
Floodwater retention and storage — This functional value is generally associated with headwater wetland systems. These systems are not present in the waters of the United States that would be impacted by the proposed project. Within the region that contains the project area, there are several very small wetland systems. These small wetland areas are of a size and are distributed in such a manner that they do not affect, in any measurable fashion, the quantity of water discharging to the Gila River during a storm event capable of generating flows to the river. Xeroriparian habitats adjacent to waters of the United States potentially impacted by the project can influence to some degree the timing of stormwater discharges from the project area. Other than areas of direct impact, xeroriparian habitats are not expected to be significantly altered downstream of the project. This is not a function of waters of the United States impacted by the project.
Groundwater discharge — The DP seep occurs within the footprint of the Dos Pobres mine site. This is the only discharge point that will be directly impacted by the proposed action. As a point of discharge, the primary functions provided by this site are the surface water (created by an impoundment of sandbags to water cattle in the bottom of the drainage) and the increased plant biomass and associated habitat values that result from increased availability of water. One other discharge point in the region that may be affected is the Watson Wash Hot Well. Head pressure in this uncapped artesian well located within the lower reaches of Watson Wash is predicted to be reduced by 0.72 feet. Effects to functions and values associated with this discharge are expected to be discountable. Further, due to concerns regarding the water quality of the Gila River and recreational uses at the well site that are not related to proposed mine activity, the well may be capped and, therefore, the potential effects of mine development become moot.
Groundwater recharge — The arroyos that are jurisdictional within the project area contribute to recharge of the regional aquifer system during flow events. This mountain front recharge component of the regional hydrologic cycle was considered in the regional groundwater model prepared for this Project. The removal of mountain front recharge is reflected in that model's predictions of Project impacts to groundwater and surface flows in the Gila River. Mitigation of potential impacts to these resources is being incorporated into the Project's Mitigation and Monitoring Plan.
Water quality maintenance — This functional value for waters of the United States is generally associated with wetland systems where the microbial actions of anaerobic and aerobic bacterial communities have been demonstrated to enhance water quality. These wetland systems are not present in the project area and waters of United States in the project area do not provide this function.
Historic, cultural, scenic, or recreational value — None of the arroyos associated within the project area are: 1) part of or are considered eligible for the Wild and Scenic River System; 2) provide unique recreational opportunities; nor 3) provide outstanding scenic values that are disproportionately high when compared to the values provided by adjacent uplands when viewed from nearby communities. This function does not require mitigation or further consideration.

1.3.2. Impact Assessment

The Project will directly impact 21.4 acres of waters of the United States. An additional 93.2 acres of jurisdictional waters may be indirectly impacted due to stormwater diversions and mine development activities that reduce contributing watershed areas of the downstream washes. The total area affected is 114.6 acres. Determination of the extent of downstream impacts associated with dewatering is based upon the recovery of channel flows to their pre-disturbance peak flow for the 100-year storm event (Q_{100}) at the downstream extent of direct impacts.

For areas subjected to direct impacts, the functions associated with those jurisdictional waters are assumed to be completely lost. For jurisdictional waters indirectly impacted by stormwater diversion, the functions provided by these drainages will not be completely lost; they will still convey stormwater and maintain habitats of higher function than the adjacent uplands. To determine the acreage of mitigation required for impacted waters based upon impacted functions, we assumed that the maximum impact at any point within areas of indirect impact would be 50 percent. This estimate is based upon the professional judgment of the wildlife resource agencies evaluating project impacts and was determined after review of the characteristics of the resources impacted and the nature of the downstream effects. Based upon this analysis, mitigation will be required for 68 acres of jurisdictional waters of the United States.

1.4. Responsible Parties

All phases of mitigation plan implementation and the management of the habitat mitigation bank will ultimately be the responsibility of the Phelps Dodge Mining Company's director of environmental operations.

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2. DOS POBRES/SAN JUAN PROJECT HABITAT MITIGATION AND MONITORING

2.1. HABITAT MITIGATION AND MONITORING OBJECTIVES

Habitat mitigation measures and monitoring objectives will have both onsite and offsite components. A combination of techniques, including creation of riparian habitats, enhancement of existing riparian and wetland habitats, and preservation of riparian and lotic habitats will provide offsite mitigation. Offsite mitigation objectives will be accomplished at three separate sites within the Safford Valley, on properties adjacent to the Gila River. The following offsite mitigation goals and objectives for this project have been established to provide the 68 acres of mitigation required to compensate for the Project's impacts to jurisdictional waters of the United States that would result from development of the Project:

- Create 30 acres of riparian habitat,
- Enhance 18 acres of riparian and wetland habitat, and
- Preserve 160 acres of riparian habitats.

Monitoring efforts will include documentation of potential impacts to waters of the United States and the effectiveness of implemented mitigation measures. Onsite monitoring activities will focus on the evaluation of potential indirect impacts to waters of the United States that may result downstream from surface water diversions. Offsite monitoring will focus on evaluating and reporting on restored, enhanced, and preserved habitats; and will quantify vegetation changes associated with restoration efforts.

2.2. OFFSITE HABITAT MITIGATION

2.2.1. Offsite Habitat Mitigation Location, Types, and Compensation Ratios

2.2.1.1. Site Locations

Three mitigation properties, owned by PDC and located throughout the Safford Valley, have been identified for use for the Plan (Figure 2). These sites have been named for nearby towns. Starting at the western end of the Safford valley and working eastward, the properties are: 1) the Fort Thomas Mitigation Site, 2) the Pima Mitigation Site, and 3) the Solomon Mitigation Site (Figure 2). Each of these sites is part of an active farm owned by PDC and leased to area farmers. Portions of the three properties that have been identified for mitigation purposes will be managed for their natural habitat values by PDC in perpetuity. In the unlikely event of a transfer of title, the relevant portions of the mitigation properties will have an appropriate conservation mechanism in place that limits land use to the mitigation purposes outlined in the Plan. These mechanisms specifically eliminate grazing and pasturage of domestic livestock and activities that would require the clearing of vegetation within habitat restoration, enhancement, or active management/ preservation areas.

The Fort Thomas mitigation site is part of an approximately 550-acre farm located northwest of the town of Fort Thomas, on the south bank of the Gila River (Figure 3). The river runs through the northernmost quarter-quarter section of the property. Currently, the farm has 295 acres of active agricultural fields and 64 acres of cleared pasture. Photosheet 1 provides ground photos of the property. As part of the habitat mitigation program for the Dos Pobres/San Juan Project, 100 acres of riparian habitat, including the portion of the site traversed by the Gila River, will be set aside and preserved in place for management of its natural habitat values.

The Pima mitigation site is part of an approximately 120-acre farm located northeast of the town of Pima, on the south bank of the Gila River (Figure 4). The easternmost portion of the northern quarter-quarter section of this parcel was damaged during the 1993 flood and is not currently in agricultural use. The flood damaged portion of the property has become primarily riparian in nature and is variously dominated by tamarisk, willow, and cattail. Currently, the farm has almost 100 acres of land in active agricultural production. Photosheet 2 provides ground photos of this property. Within this parcel, two mitigation strategies will be utilized: 1) restoration of a portion of a Sudan grass pasture to riparian habitat dominated by native vegetation and 2) enhancement of existing wetland habitats, in part by the removal of exotic plant species. In all, 26 acres of riparian habitat will be created at this site and 18 acres will be improved through habitat enhancement.

The Solomon mitigation site is part of an approximately 220-acre farm located northeast of the town of Solomon, primarily on the north bank of the Gila River (Figure 5). The Gila River generally runs along the southern boundary of the property. Currently, the farm has 175 acres of active agriculture. Approximately 60 acres of the property are riparian or lotic habitat. Photosheet 3 provides ground photos of proposed mitigation areas. Within this parcel, two mitigation strategies will be implemented: restoration of disturbed lands to a riparian habitat dominated by native vegetation, and preservation of existing riparian and wetland habitats. Specifically, 60 acres have been targeted for preservation and 4 acres have been identified for habitat restoration efforts.

2.2.1.2. Mitigation Types

Restored habitats for mitigation are habitats that will be developed through active restoration of disturbed lands. This mitigation type will occur on existing agricultural fields or on other highly disturbed areas where establishment of riparian vegetation through active restoration programs is expected to be successful and to contribute positively to the functions and values of the Gila River system. Two areas have been identified for these efforts, a 26-acre pasture at the Pima mitigation site and an approximately 4-acre area, disturbed during the construction of a levee, at the Solomon mitigation site. Restoration will be accomplished through plantings of native tree and shrub species suitable for the physical characteristics of each site and, as appropriate, seeding with suitable grasses and forbs.

Habitat enhancement for mitigation will occur through modification of existing riparian and wetland habitat. The portion of the Pima mitigation site selected for this effort is an existing wetland/riparian plant community in the early stages of development. The wetland/riparian habitat at the Pima mitigation site will be enhanced through vegetation management activities that will limit the density and dominance of tamarisk. This will be accomplished at this site by initial removal of exotic vegetation (primarily tamarisk saplings) to create a competitive advantage to native vegetation currently becoming established within this area.

Mitigation through active management and preservation of existing habitats will occur at two of the mitigation sites (the Fort Thomas and Solomon mitigation areas), to protect them from future management/land use activities that would diminish their riparian/wetland functions. Both of these sites contain areas that support existing riparian and lotic habitats. During spring 1998 surveys, five southwestern willow flycatchers (WIFL) were detected within the areas of the Fort Thomas site and a nest for common black hawk was detected at the Solomon Mitigation site. All of the preserved habitat areas will provide protected connections between the restored or enhanced habitats and the Gila River riparian corridor, increasing the acreage of protected habitats along the Gila River. Preservation will be accomplished by placing restrictive covenants on all of the lands incorporated into the mitigation plan for the Project.

2.2.1.3. Compensation Ratios

Compensation ratios for these sites are based on the nature and function of the mitigation type relative to the functions and values of the impacted waters of the United States. Because of the high habitat value of the mesoriparian and hydroriparian sites selected for mitigation, all of these habitats provide, or have the potential to provide, significantly greater habitat function than xeroriparian habitats that will be impacted by the Project. Because the nature and functions of restored habitats will be greater than those of impacted jurisdictional waters, restored habitats will provide 1:1 compensation for project impacts to jurisdictional waters. Because enhanced areas already have, to some degree, the functions normally attributed to waters of the United States, the compensation ratio is less for this mitigation type than for restored habitats. The compensation ratio for habitat enhancement will be 3:1 for project impacts to jurisdictional waters. Preservation of riparian habitats will provide 5:1 compensation for project impacts to jurisdictional waters. These ratios represent the number of acres of mitigation habitat, restored, enhanced, or preserved to offset one acre of impacted waters of the United States. Table 3 provides a summary of the location, types, compensation ratios, and mitigation credits for the Dos Pobres/San Juan project.

Table 3. Summary of the location, types, compensation ratios, and mitigation credits for the Dos Pobres/San Juan project.

Mitigation Site	Mitigation Type	Acreage	Compensation Ratio	Mitigation Credit (acres)
Fort Thomas	Preservation	100	5:1	20
Pima	Enhancement	18	3:1	6
	Restoration	26	1:1	26
Solomon	Preservation	60	5:1	12
	Restoration	4	1:1	4
Total		**208**		**68**

2.2.2. Offsite Habitat Mitigation Implementation Plan

2.2.2.1. Fort Thomas Site Implementation

Mitigation implementation at the Fort Thomas site will consist of establishing appropriate measures to protect lands targeted for preservation from future management/land use activities, which would diminish riparian wetland functions and values. These measures will include both fencing to provide a physical restriction to human and livestock access and restrictive covenants tied to the deed of each parcel to limit potential future uses of these areas. Fencing design will be typical multi-strand barbed wire with the bottom strand barbless to provide opportunity for wildlife egress and ingress without injury. Barbed strands will be necessary to insure control of local livestock that may be attracted to the resources within the preservation area and have become accustomed to testing and exploiting fencing limits and weaknesses. Gates or step crossings will be provided in those areas required to allow access for monitoring. In areas where fencing is not practicable, property boundary delineators and signage will be utilized to inhibit trespass and unauthorized access. Figure 3 illustrates the parcel identified for preservation and perimeter fencing to be constructed at the Fort Thomas mitigation site.

2.2.2.2. Pima Site Implementation

Both enhancement and restoration activities will occur at the Pima Mitigation site. The locations of the mitigation efforts at the Pima site are depicted in Figure 4. The enhancement and restoration efforts at the Pima Site do not require a permit for implementation. With the approval of the COE's project manager, enhancement activities were initiated at the Pima Site in April of 1999.

Because the Pima site requires the greatest amount of enhancement and restoration work, more detailed baseline information has been developed for this site. Depth to groundwater, soils, and baseline vegetation sampling has been conducted to evaluate basic characteristics that are important for implementation of the proposed mitigation measures.

2.2.2.2.1. Pima Site Habitat Enhancement

Habitat in the mitigation enhancement area at the time the initial Plan was compiled was generally characterized by dense even-aged stands of Sand Bar Willow averaging 9 to 10 feet in height (ca. 3 meters [m]) that were interspersed with large areas of sand and river cobble devoid of vegetation. In 1998, the portion of the Pima Mitigation Site proposed for habitat enhancement (Figure 4) was analyzed to establish baseline vegetation conditions. One meter-squared plots were randomly located along east to west transect lines through the enhancement portion of the property. Thirty-three plots were read, Sand Bar Willow (*Salix exigua*) was the dominant species encountered in the sample composing 76 percent of the total vegetation. Salt cedar (*Tamarix pentandra*) made up 22 percent, and cottonwood (*Populus fremontii*) and seep willow (*Baccharis glutinosa*) 1.46 and 0.44 percent, respectfully. Almost all of the saplings sampled had stem diameters less than 1.5 inches (3 centimeters [cm]).

The majority (more than 99 percent) of the tamarisk plants occurring onsite during the 1998 initial baseline analysis were small with stem diameters less than approximately 4 cm. Salt cedars in the enhancement area were generally single-stemmed individuals spread unevenly throughout the willow stands at densities from 1 to 10 stems per square meter. The salt cedar at the site were generally less than 2 m in height with very little foliage development due to the heavy shading effect from the dense willow overstory. These salt cedars did not contribute significantly to the overall structural characteristic of the enhancement area. A few plants, occurring as isolated individuals, had stem diameters from 7 to 12 cm and ranged from 2.5 to 4 m in height. These larger plants did not form, nor were they part of, patches of habitat typical of habitats known to be utilized by WIFL within the Safford Valley. These larger, isolated salt cedars were generally located in the central and western portions of the site.

The 1998 WIFL survey of the property detected one WIFL at the extreme southeast corner of the parcel of land targeted for enhancement activities. No WIFL nests were located during any of the three site visits completed pursuant to the approved survey protocol. The area in which birds were located is an even age stand of sand bar willow averaging approximately 20 feet (ca. 6.1 m) in height that barely extends onto the mitigation site. No WIFL were detected in the lower canopy habitats that characterized the habitat enhancement mitigation area at that time, and at the time enhancement activities were completed.

SWCA, Inc. completed three surveys of the Pima Enhancement site during spring of 2000 (Appendix A). During their surveys, 14 territories were identified within the study area and a 15th territory was identified just east of the study area boundary. Of these territories, 13 active nests were located within the boundary of the Pima Enhancement site. Of these 13 nests, SWCA reported that 12 were located in narrowleaf willows and one was located in a tamarisk.

During the spring of 2001, USFWS conducted a single survey of the site pursuant to the monitoring agreements made during the development of this Plan. During this survey, 36 singing male WIFL were detected which indicates that there may be 36 active territories within the enhancement site. This is likely a conservative estimate of the number of WIFL territories within the enhancement area.[3]

Initial Control Effort. After discussions with the U.S. Fish & Wildlife Service (USFWS) in the early spring of 1999, Phelps Dodge proceeded with implementation of initial enhancement activities prior to the return of WIFL to avoid the potential for take, as defined in ESA regulations, with regards to this species and the mitigation program outlined in this Plan. Initial implementation control efforts began at this site during April 1999. A summary of tamarisk control guidelines and control efforts initiated at the site is provided below.

Tamarisk control activities were implemented at the Pima location on April 6, 1999, and all cut and initial treatment activities were completed by May 1, 1999. Some stacked tamarisk cuttings were removed from the site by hand from May 1st through May 4th as part of final site cleanup efforts. The focus of enhancement efforts has been the western, central, and northern portions of the 18-acre enhancement area, with less effort occurring in the southeast corner near the WIFL detection. Pursuant to discussions with the USFWS, enhancement efforts in the southeast portion of the mitigation area occurred in early April in order to complete activities in these areas prior to the expected return of WIFL. A brief discussion of the specific control methods follows.

Tamarisk removal at the site was implemented using the cut-stump method. The contractor provided a crew of 8 to 11 individuals throughout the four-week control effort. The crew cut tamarisk using pruning shears, loppers, and handsaws for larger plants.[4] The contractor was instructed to remove plants as close to ground level as possible to maximize the effect of herbicide treatment. Following cutting, stumps were treated with a 50 percent volume-to-volume solution of Rodeo®, a herbicide approved for aquatic applications. Food coloring was incorporated into the herbicide mixture to track application coverage, and ensure complete treatment of the remaining salt cedar stumps. All cut portions of salt cedar were gathered, bundled, and hauled from the site for disposal at a local landfill. Eighty-five, 7-yard dump truck loads of tamarisk and other trash and debris were removed from the site.

Supplemental Control. Evaluation of post-treatment control was conducted one month after the completion of initial control measures using randomly located, 1-meter-square, plots. These data indicated that initial control efforts resulted in a 20 percent mortality of salt cedar plants with an additional 10 percent demonstrating some herbicide effect in the form of aberrant or chlorotic growth. A follow-up herbicide treatment was initiated on June 22, 1999 in the southwestern portion of the site and the inner open areas adjacent to the river. Foliar application of a 2 percent solution of Rodeo® in wet areas, and a solution of two percent Rodeo® and two percent Arsenal® in dry areas was made to new growth on salt cedar stumps. This supplemental control effort was very successful, achieving well in excess of 90 percent control.

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3 Greg Beatty, USFWS, 6 June 2001 email to J. Korolksy Phelps Dodge Safford, Inc.

4 The majority (> 99 percent) of the tamarisk plants occurring on site were small with stem diameters less than one inch. A few plants, occurring as isolated individuals, had stem diameters from two to five inches. These large plants did not form patches of habitat typical of habitats known to be utilized by WIFL.

Additional control activities will continue at this site if authorized. These control activities would only be implemented after coordination with the USFWS and the COE that resulted in the authorization from both entities to proceed. If control activities were authorized to proceed, they would be limited in the following ways. The applicant will continue control efforts through 2009. During this period, the applicant will implement a tamarisk control program in the fall of each year, after WIFL have migrated from the site and prior to tamarisk going dormant. This tamarisk control effort will be limited to seedlings and saplings no greater than four feet in height. The applicant will continue to coordinate with the COE and the USFWS regarding tamarisk control technologies and timing throughout the maintenance period to ensure that adverse impacts to WIFL are avoided. If at any time the COE or USFWS determine that further control efforts may adversely impact WIFL, the applicant will cease control efforts. Direction to cease control efforts at this site by either the COE or the USFWS will not adversely influence the determination that enhancement objectives have been successfully achieved at this site.

Other Enhancement Activities. The Pima Habitat Enhancement area contains approximately four acres of habitat that will be actively managed for the establishment of potentially suitable WIFL habitat[5] (The Pima Active Management Area; Figure 6). The management actions implemented within the Active Management Area may include, but will not necessarily be limited to supplemental planting, fencing, irrigation, construction of fire breaks, and other activities that may, from time to time be appropriate to achieve restoration objectives.

2.2.2.2.2. Pima Site Habitat Restoration

Additional work planned for the Pima site will include establishment of a mesquite bosque on a 26-acre portion of the property that is currently a sudan grass pasture (Figure 7). The northeast corner of this parcel has an existing stand of riparian vegetation that was heavily damaged by fire. This portion of the site will be in-filled with plantings between the existing vegetation that survived the fire. Mesquite was selected based upon the soil conditions of the site and because this species will require less irrigation for establishment than would less drought-tolerant riparian species.

On August 10, 1998, three auger holes were drilled at the 26-acre restoration site to characterize depth to groundwater and soil characteristics. These holes were augered within the sudan grass pasture designated for restoration. The auger sites were orientated from east to west providing a cross-section of groundwater depth perpendicular with the river. Groundwater depth varied from 3 to 9 feet with the highest groundwater elevations occurring on the western edge of the site away from the river and next to existing agricultural fields. Soils collected at various depths from these auger holes were sent to the United Horticultural Supply in Tucson for analysis of texture, pH, and electrical conductivity. Soil textural classes ranged from Loam to Sandy Clay Loam with Silt Loam and Clay Loam predominating. Soil pH ranged from 8.0 to 8.7 with an average pH of 8.37. Electrical conductivity ranged from 0.9

[5] The characteristics of potentially suitable WIFL habitat were defined for this site through consultation with the USFWS. At the Pima Enhancement Site, potentially suitable WIFL habitat will consist of 400 living stems per acre established as either volunteers or planted stems. These plants will be either native or non-native tree species that have already become established or may become established in the future in part through the active management efforts practiced by Phelps Dodge at this site. A minimum of 0.84 acres of the four-acre area identified for the establishment of potentially suitable WIFL habitat will achieve the targeted success criteria.

mmhos/cm to 14.8 mmhos/cm with an average conductivity of 5.41 mmhos/cm. Soluble salts ranged from 576 parts per million (ppm) to 9,472 ppm with an average value of 3,465 ppm.

Contract grown mesquite (*Prosopis velutina*), cottonwood (*Populus fremontii*), netleaf hackberry (*Celtis reticulata*), Mexican elderberry (*Sambucus neomexicana*), grey-thorn (*Zizyphus obtusifolia*), desert hackberry (*C. pallida*), and wolf-berry (*Lycium pallidum*) will be cultivated and planted within the habitat restoration area (Figure 7). Container grown plant material will be grown using traditional nursery containers and the tall pot cultivation method developed at Joshua Tree National Monument. During future monitoring efforts, comparisons between traditional 1-gallon and tall pot containers will be made to determine if the tall-pot containers were more effective in establishment or if they positively affected growth rates.

The tall pot cultivation method uses a container constructed of 6-inch polyvinylchloride (PVC) pipe cut into 30-inch sections as an initial planting container. The bottom of the container is constructed of ¼-inch wire mesh and held in place with two crossed wires. Figure 8 provides a schematic view of the tall pot design. The pot is filled with soil and the plants or seeds are placed in the soil. Plants will be contract-grown in the nursery for up to one year to allow the roots to fill the pot volume. The plants will be transplanted to the field by first augering a hole to fit the PVC pot. The crossed wires will be removed, and the potted plant will be lowered into the hole. The pot will be removed and the hole backfilled. Growing the trees in this manner allows for the maximum development of root biomass to facilitate establishment and exploitation of shallow underlying water tables.

Table 4 provides a summary of the proposed species and quantities. Species composition and planting densities provided for by the planting plan were based on a review of available literature on mesquite forest ecology by Stromberg (1993). Stromberg's review indicates that historically mature bosques have been described as having an open, park-like appearance, with low densities of single-trunked trees. The author notes that these observations differ from contemporary bosques, which are primarily composed of high stem densities (200 to 800/ha) of young or second growth multi-trunked trees.

Table 4. Proposed Woody Species and Planting Densities for the Pima Mitigation Site

Scientific Name	Common Name	# of Plants	Percent Composition
	TREES		
Prosopis juliflora	Mesquite	1,595	80
Populus fremontii	Fremont cottonwood	40	2
Celtis reticulata	Netleaf hackberry	40	2
Sambucus neomexicana	Mexican elderberry	80	4
	SHRUBS		
Zizyphus obtusifolia	Grey-thorn	80	4
Celtis pallida	Desert Hackberry	80	4
Lycium pallidum	Wolf-berry	80	4
TOTAL	**All Species**	**1,995**	**100**

Containerized trees and shrubs will be planted in an irregular configuration to simulate natural establishment and stand formation patterns. A mosaic of trees will be established with intervening open areas to be planted in native grasses in order to provide structural diversity and increased habitat value to the mitigation site. Prior to planting trees, the mitigation area will be tilled to establish the proper seedbed conditions and then seeded with base seed mix summarized in Table 5. This will provide soil cover to prevent erosion and loss of topsoil in these areas. Additionally, herbaceous plant establishment will provide shading cover that will inhibit seed germination and seedling establishment of exotic plants such as salt cedar in these areas. Additional species will be added to the base seed mix based on the availability and price. These species are listed in Table 6. Figure 7 provides a planting plan for the Pima Mitigation site habitat creation area.

Table 5. Base Seed Mix for the Pima Mitigation Site

Scientific Name	Common Name	Pounds Pure Live Seed / Acre
Sporobolus airoides	Alkali Sacton	1
Sporobolus giganteus	Giant Dropseed	1
Leptochloa dubia	Green sprangletop	2
Setaria macrostachya	Plains Bristlegrass	3
Panicum virgatum	Switch grass	2
Panicum obtusum	Vine Mesquite	3
Sesbania macrocarpa	Colorado River Hemp	2
Plantago insularis	Wolly Plantain	1
Sphaeralcea ambigua	Desert Mallow	1

Table 6. Supplemental Species that may be Included within the Base Seed Mix (Table 5) Depending Upon Their Availability and Price.

Scientific Name	Common Name	Pounds Pure Live Seed / Acre
Clematis ligusticifolia	Clematis	1
Cocculus diversifolius	Snail Seed	1
Echinopepon wrightii	NA	1
Sarcostemma heterophyllum	Climbing milkweed	1
Bebbia juncea	Sweet Bush	3
Stephanomeria pauciflora	Desert Straw	3
Brickellia atractyloides	Brickellia	3

Flood irrigation will be utilized for establishment of these plants. An existing open channel system connects a well that is partially owned by PDC to this field. Modifications of the existing system will be required to focus the water supply on the portion of the field targeted for restoration. These modifications will include repair of the existing delivery channel from the well, construction of a new portion of channel to deliver the irrigation water to the northeast portion of the field, and construction of berms to evenly distribute irrigation water across the mitigation area. These repairs and modifications will be made prior to planting of the trees and seeding of the mitigation area.

The perimeter of the areas targeted for mitigation will be fenced. Fencing design will be typical multi-strand barbed wire incorporated with the bottom strand barbless to provide wildlife egress and ingress. Gates will be provided in required areas to allow access for monitoring as well as to adjacent lands that will remain in agricultural production and require access to be maintained. In areas where fencing is not practicable, property boundary delineators and signage will be utilized to inhibit trespass and unauthorized access.

2.2.2.3. Solomon Site Implementation

2.2.2.3.1. Solomon Site Habitat Restoration

Containerized native tree and shrub plantings (tall pot and one gallon nursery stock) and seeding will be utilized to establish riparian habitat within a portion of the Solomon site that has been previously disturbed during construction of a flood-control levee. Figure 9 provides a planting plan of the work that has been proposed for the Solomon site. It is important to note that the density and distribution of tree plantings reflects the elevation gradients that occur within this mitigation site and the requirements of the plant species selected for planting. The planting densities proposed in the planting plan (Figure 9) reflect input provided by the USFWS. 1.16 acres of potentially suitable WIFL habitat will be established as part of the Solomon planting plan (the Solomon Active Management Area). The species mix planted within the 1.16-acre area targeted to create potentially suitable WIFL habitat will reflect the structure and species composition found within WIFL nesting habitat documented in the spring 2000 survey of the Pima

Enhancement Mitigation site. The location and nature of plantings at this site will reflect site conditions found at the planting site at the time of actual implementation. Any modifications to the plan that may be necessary to reflect the site conditions at the actual time of planting will be required to achieve the objectives of this mitigation requirement.

Prior to planting trees, the mitigation area will be seeded with base seed mix summarized in Table 5. This will provide soil cover to prevent erosion and loss of topsoil in these areas. Additionally, herbaceous plant establishment will provide shading cover that will inhibit seed germination and seedling establishment of exotic plants such as salt cedar in these areas. Additional species (listed in Table 6) will be added to the base seed mix based on the availability and price.

A well owned by PDC is available to provide supplemental irrigation using either flood or drip irrigation methods. Once the trees have developed a sufficient root system to exploit the underlying groundwater, irrigation will no longer be required to maintain the restored community and irrigation efforts will be terminated.

2.2.2.3.2. Solomon Site – Active Management/Preservation

Mitigation through active management/preservation of existing habitats will also be employed at the Solomon mitigation area to protect them from future management/land use activities that would diminish their riparian/wetland functions. This site contains areas that support existing riparian and lotic habitats. Sixty acres of existing cottonwood/willow habitat will be preserved for Project mitigation. All of the preserved habitat areas will provide protected connections between the adjacent habitats and the Gila River riparian corridor. Preservation will be accomplished by establishment of restrictive covenants on the deed of the lands incorporated into the mitigation plan for the Project. Figure 5 illustrates the boundaries of the Solomon mitigation site.

The perimeter of the areas targeted for mitigation will be fenced. Fencing design will be as described for the Pima and Fort Thomas sites — typical multi-strand barbed wire fence with the bottom strand barbless to provide wildlife egress and ingress. Gates will be provided in those required areas to allow access for monitoring. In areas where fencing is not practicable, property boundary delineators and signage will be utilized to inhibit trespass and unauthorized access.

2.2.3. Habitat Mitigation Maintenance

Maintenance of habitat mitigation sites will consist of the inspection and repair of perimeter fencing, irrigation of plantings, and upkeep of irrigation systems. Maintenance activities involving work that requires numerous people, vegetation disturbance, or potential noise will be scheduled as to avoid, to the maximum extent practical, seasons when WIFL are likely to be using the mitigation sites.

Irrigation schedules will be based on specific field conditions (soil texture, run length), the availability of precipitation, and the rate at which planted materials are able to sufficiently exploit underlying groundwater. The overall irrigation strategy will be to provide sufficient moisture to allow plant establishment while weaning the plants of supplemental water requirements and encouraging them to develop sufficient root systems to exploit shallow underlying water tables.

2.2.4. Habitat Mitigation Success Criteria

Success criteria for Restored Habitats and the Active Management/Preservation habitat mitigation types are described in Table 7. These quantitative measures will be used to determine when implementation of specific mitigation elements required for the Dos Pobres/San Juan habitat mitigation program have been successfully completed.

PDSI will not be held responsible for replacement or repair of impacted mitigation areas after success criteria have been achieved and accepted by the COE when adverse impacts result from any act of God, including fire, flood, or pestilence. Should such an event occur prior to the achievement of the success criteria established in this document, PDSI will contact the Corps as outlined in the Section 2.2.6, Contingency Measures, to determine appropriate measures to achieve mitigation success.

2.2.5. Monitoring and Reporting

2.2.5.1. Reporting and Monitoring Requirements – All Sites

Two copies of an initial monitoring report will be submitted to the COE after the permit is issued and as soon as mitigation sites have been created, enhanced, and preserved. All active (restored or enhanced) mitigation sites will be monitored annually. Two copies of the annual monitoring report, one for distribution to the USFWS, detailing the results of all monitoring activities since completion of the last report will be submitted to the COE on November 1st of each year pursuant to the schedule outlined in Section 2.4. Monitoring efforts will continue for a minimum of 10 years or upon the achievement of mitigation success criteria, which ever occurs last. After 10 years, monitoring will not be required for any sites that have met established success criteria. Each annual monitoring report shall clearly reference the COE file number for the Project.

Table 7. Habitat Mitigation Success Criteria Summary

MMP Habitat Mitigation Location/Element	Success Criteria
Fort Thomas Site: • Active Management/ Preservation Area	• Active Management/Preservation objectives will be successfully achieved when the target land parcels have been placed under an appropriate conservation restriction and fencing and signage are in place.
Pima Site: • Restoration Area	• Restoration efforts will be considered successful when planted vegetation has been in place for a minimum of 10 years and when 80 percent of the containerized plantings are in a living, growing condition two years after cessation of the last irrigation event, which ever occurs last.
• Enhancement Area	• The Pima WIFL Active Management Area for WIFL at the Pima Enhancement Site will be considered successful when 0.84 acres of the four acres of the Pima Active Management Area have been established with a minimum of 400 living stems per acre. These stems can be established either as volunteers or via active planting programs. Plants that count towards the success criteria can be either native or non-native tree species that have already become established or may become established in the future in part through the active management efforts practiced by Phelps Dodge at this site. Within this 0.84-acre area, canopy-height will average a minimum of 15 feet. The acreage of potentially suitable WIFL habitat that is established within the WIFL Active Management Area at the Pima Site will be contiguous with existing potentially suitable or suitable WIFL habitat so that, combined they will provide a minimum patch size of two acres.
	The remainder of the site will be subject to following criteria. Because of the presence of willow flycatcher within the enhancement area and the degree of success achieved during the initial control effort, specific success criteria have not be established. The applicant will continue control efforts through 2009. During this period, the applicant will implement a tamarisk control program in the fall of each year, after WIFL have migrated from the site and prior to tamarisk going dormant. This tamarisk control effort will be limited to seedlings and saplings no greater than four feet in height. The applicant will continue to coordinate with the COE and the USFWS regarding tamarisk control technologies and timing to ensure that adverse impacts to WIFL are avoided. If at any time the COE or USFWS determine that further control efforts may adversely impact WIFL, the applicant will cease control efforts and continue with monitoring requirements pursuant to this MMP. Direction to cease control efforts at this site by either the COE or the USFWS will not adversely influence the determination that enhancement objectives have been successfully achieved at this site.
Solomon Site: • Restoration Area	• For 2.84 acres of the four acre restoration area restoration efforts will be considered successful when planted vegetation has been in place for a minimum of 10 years and when 80 percent of the containerized plantings are in a living, growing condition two years after cessation of the last irrigation event, which ever occurs last. • Special success criteria for the 1.16-acre Solomon WIFL Active Management Area have been established in consultation with the USFWS. Within this area, success criteria are: 1) Four hundred (400) living native tree stems per acre, and 2) a canopy height that will average a minimum of 15 feet. The acreage of potentially suitable WIFL habitat that is established with the WIFL Active Management Areas at the Solomon Site will be contiguous with existing potentially suitable or suitable WIFL habitat so that, combined they will provide a minimum patch size of two acres.
• Active Management/ Preservation Area	• Active Management/Preservation objectives will be considered to be successfully achieved when the target land parcels have been placed under an appropriate conservation restriction and fencing and signage are in place

The Mitigation and Monitoring report will include the following:

1) A summary of maintenance activities (including supplemental irrigation schedules) for each site,
2) Photo-documentation,
3) A summary of growth data collected from each site, and.
4) The results of groundwater monitoring requirements outlined in Section 3.4 of this report.

Monitoring reports will be submitted to the COE Regulatory Branch office in Tucson[6], Arizona. The COE will be responsible for forwarding a copy of the monitoring report to the USFWS' Arizona Ecological Services Field Office.

Notification of successful completion of mitigation efforts will be provided with the submittal of the Annual Monitoring Report to the COE. This notification shall be clearly stated in the transmittal letter and documented within the body of the document.

Photo documentation will be provided from permanent locations that will be identified and documented within the first monitoring report submitted to the COE. Permanent photo points will be permanently marked in the field. Each mitigation site will have a minimum of five permanent photo points. Two of the minimum five photo points established at both the Pima and Solomon mitigation sites will occur within the WIFL Active Management Areas. Matched photos from permanent photo points will be provided with the monitoring reports pursuant to the schedule that has been established in Section 2.4.

Within restored and enhanced habitat areas that use supplemental irrigation during the establishment period, detailed records of the timing and duration of irrigation events will be maintained and summarized for mitigation monitoring reports.

A minimum of 20 percent of all containerized and York pole plantings used at each mitigation site will be tracked during the establishment period. Each of the tagged plants will be measured after planting, at the end of the first growing season, at the end of each subsequent growing season that irrigation is applied, and for two years following the last irrigation event. Trees will be monitored to ensure that a statistically significant increase in tree size (for the sampled population as measured by canopy diameter and height) occurs while irrigation takes place. Upon cessation of supplemental watering, a statistically significant increase in tree size may not occur and monitoring efforts are intended to identify potential die back or reduction in size that would indicate that the trees have not been sufficiently established.

Additional monitoring data may be collected to characterize plant community structure and changes in species composition with time. Methods that may be employed to achieve this effort include calculation of vertical habitat structure and species composition using the vegetation volume method and small plot

[6] In the event the Corp's Project Manager is no longer stationed in the Tucson office, reports will be submitted to the Corp's Regulatory Branch office in Phoenix, Arizona.

sampling (2dm x 5dm) to quantify herbaceous cover. These data will be collected as a supplement to the demographic data of planted trees that will form the basis for determination of success.

Stem density will be measured within the portions of the Pima Mitigation Site that were subject to habitat enhancement activities (see section 2.2.2.2.1) to determine the percentage of native versus non-native tree species. The collection of this data will be for informational purposes only; it is not tied to any specific success criteria. This sampling effort will occur during the regularly scheduled monitoring efforts described above. Stem densities will be determined utilizing the point centered quarter sampling technique. Data collected at each point will include species type and stem diameter to enable calculation of the relative dominance of each species based upon calculated measures of stem basal area within the stand. All sampling efforts will be non-destructive and will not require the removal or collection of vegetation for the determination of stand characteristics. [Collection of one or two small cuttings of sampled vegetation for voucher specimens (pressed samples) is unlikely, but a potential possibility.] Further, this effort will occur outside of the breeding and nesting season for the WIFL to avoid any potential for harassment of this species, incidental to this monitoring activity.

2.2.5.2. WIFL Monitoring – Pima Mitigation Site Only

Monitoring will include surveying the Pima Mitigation Enhancement Site for WIFL activity. Surveys will be conducted annually for five years, beginning in the spring of 2000. The first and second year (2000 and 2001) of monitoring have been completed. The results of these survey efforts are provided in Appendix A.

Phelps Dodge will be responsible for surveys conducted during the 2000, 2002, and 2004 survey seasons. The USFWS will be responsible to conduct surveys during the 2001 and 2003 survey seasons. The USFWS obligation to conduct survey will be contingent on the availability of funding to accomplish their survey responsibilities. Phelps Dodge has agreed to grant access to the USFWS or its designated representatives to conduct surveys described in this section. The USFWS has agreed to provide a minimum of two working days notice to the PDSI office prior to conducting survey. The results of the USFWS survey effort will be provided to Phelps Dodge in a timely fashion.

WIFL surveys will follow the presence/absence survey protocol that has been established for this species by the Arizona Game & Fish Department and the USFWS (USFWS, 2000; Appendix B).[7]

2.2.6. Contingency Measures

Success or failure to achieve the mitigation objectives identified for the mitigation sites will be identified in the five-year and subsequent year monitoring reports submitted to the COE. In this report, PDSI will identify the degree of success achieved, the likely causes for any failure and, if necessary, the proposed

[7] USFWS 2000. May 31, 2000 letter from Mr. Brian Arroyo, Asst. Regional Director – Ecological Services to Southwestern Willow Flycatcher Surveyors outlining revised survey protocol standards. (R2/ES-TE).

measures that will be implemented to achieve mitigation success. Should implementation of contingency measures become necessary, PDSI will schedule a meeting with the COE to establish a schedule for development and implementation.

Corrections of the foreseeable causes for not achieving the success criteria outlined in previous sections are not likely to require utilization of alternative mitigation locations. Should any problems arise that require implementation of contingency measures on other than the proposed mitigation sites, PDSI will coordinate with the COE who will, in turn, contact appropriate resource agencies.

2.3. MONITORING OF DOWNGRADIENT JURISDICTIONAL DRAINAGES

Waters of the United States located downgradient of the proposed mine site that will be de-watered as a result of mine development will be monitored for 15 years to determine if the mitigation provided at off-site mitigation areas is adequate. If it is determined that the impacts were greater than assumed for mitigation purposes in this Plan, additional mitigation will be required. However, if the impacts were less than assumed for mitigation purposes, excess mitigation will be made available for use by Phelps Dodge to meet future mitigation needs. Monitoring activities are based upon the functions and values associated with the impacted drainages.

It is anticipated that the effects, if any, associated with stormwater diversion efforts will take several years to become apparent. The 15-year monitoring period should be more than adequate to ascertain the nature and extent of impacts to downstream resources that may result from the stormwater management program implemented at the mine. While it is certainly possible that a significant storm event will not occur during the monitoring period, this does not detract from the efficacy of the monitoring effort, nor does it argue for a longer monitoring period. The xeroriparian systems that provide much of the functional value of the downstream jurisdictional areas are dependent upon more frequent rainfall and runoff intervals than would be represented by lower return-frequency storm events. We believe that the systems in question are in fact primarily dependent upon local runoff from adjacent hillsides and not upon the less frequent storm events that cause these normally dry washes to flow all the way to the Gila River. The plant species that dominate these arroyos are quick to respond to drought; it is one of the key adaptive mechanisms that have allowed them to survive in the arid southwest. The response of vegetation to reduced availability of water because of reductions in watershed size, if it is a factor determining the nature and character of xeroriparian habitats, will be reductions in the size and density (biomass or vegetation volume) of plants within these habitats. As many of the plant species within the xeroriparian habitats potentially affected are also common upland species in the area, significant shifts in species composition will not be as apparent, though species, such as canyon ragweed may become less common. The detailed measurement of vegetation and habitat characteristics within these systems will allow for the detection of any significant impact or trends. The data collected during this effort will not only be used to determine the adequacy of implemented mitigation programs, they will also prove useful for future analysis of impacts when the proposed fill activity results in significant reductions in the contributing watershed area for jurisdictional waters that are otherwise unimpacted.

The primary function and value of the jurisdictional waters impacted by the proposed Dos Pobres/San Juan mine project is their habitat value for wildlife (see summary provided in Table 2). Other functions and values identified in Table 2 include sediment transport and stormwater conveyance. To provide specific measures of riparian habitat value, measures of vegetation volume have been utilized during baseline data collection (Table 1). These data provide a basis for long-term habitat evaluation and impact assessment[8] and will be repeated during comprehensive monitoring efforts.

To monitor changes in channel morphology, the monitoring program will include monitoring of channel geomorphology (Rosgen Classification Scheme) at selected channel cross-sections associated with the vegetation and habitat monitoring locations. These data will be used to supplement and aid in the interpretation of vegetation/habitat analysis outlined below.

As provided in the baseline data collection presented in Table 1, vegetation analysis will include calculation of total vegetation volume index (TVVI); vegetation volume index by 1-m canopy increments (ground to1 m, 1 to 2 m, 2 to 3 m, 3 to 4 m, 4 to 5 m, 5 to 6 m, 6 to 7 m, 7 to 8 m, and greater than 8 m); vegetation volume index by species ($VV_{(s)}$); and woody perennial vegetation species richness (the number of species hit during sampling and the number of species observed in the transect vicinity). Where appropriate, data will be collected at approximately the same transect locations as provided in the initial sampling effort summarized in Table 1. Data collection points will be stratified by drainage size and location downstream from the mine facility. In addition, sampling locations will be placed in drainages unaffected by diversion activities to provide adequate control.

The TVVI (the vegetation volume index as cubic meters of vegetation per square meter of surface area) for each transect is calculated as follows. At regular intervals along each sampling transect, a 6-m pole will be held vertically. A "hit" is recorded for each dm above ground in which vegetation occurs within 1 dm of the pole used to provide the vertical line intercept along the horizontal transect (this technique essentially samples a series of cylinders that are 1 dm high with a radius of 1 dm). Hits are recorded by 1-m canopy layers. The total number of "hits" possible within each meter of canopy above ground at each sample point ranges from 0 to 10 (no more than one hit is possible for each decimeter segment). Plant species are identified for each "hit".

TVVI for each transect equals:

$$h/10p$$

8 Because it is impractical to measure all of the wildlife species associated with a given habitat type, indirect measures of wildlife value utilizing habitat parameters are typically used to quantify or estimate habitat value. In the arid southwest higher volumes of vegetation are typically associated with increases in available moisture and thus normally are found to correlate strongly with productivity.

Where h = the total number "hits" summed over all meter layers and all points, and p equals the total number of points at which measurements were taken at each transect. The unit of measure for TVVI is cubic meters of vegetation per square meter surface area.

This equation can then be simply modified to document the vertical distribution of vegetation within the community by summing the number of hits (h) by canopy layer, species, or a combination of both.

Twelve drainage categories and three control categories will be delineated as defined in Table 8 to provide representative sample for analysis purposes. The value within each grid cell indicates the anticipated number of transects per sampling category. Within each sample category three drainages will be measured with two transects sampled in each drainage (n=6).[9] Sample size can be kept relatively small because the base value of interest is the change along each transect, not the absolute TVVI measured at each transect.

Table 8. Sampling Matrix — Monitoring for Downgradient Jurisdictional Drainages

Drainage Size Class	Number of Transects					
	Drainage Reach Defined by the Percent Recovery to Pre-Diversion Q_{100}					
	0-25%	26-50%	51-75%	76-100%	Control	TOTAL
1	6	6	6	6	6	30
2	6	6	6	6	6	30
3	6	6	6	6	6	30
TOTAL	18	18	18	18	18	90

These data will be used to compare baseline condition of xeroriparian habitat to measured conditions at years 5, 10, and 15. The degree of responses will be determined by calculating the percentage change in stand structure for each drainage category (defined by size and location below the mine site). The percentage change in TVVI for transects within each category will be used to estimate the total impacts to jurisdictional waters. If the total percent change, weighted by drainage size class,[10] is less than the negative 50 percent assumed for impact assessment at the end of the 15-year period, credit will be provided for the implemented mitigation program by prorating the percentage change against the acreage of mitigation required for downstream impacts. If additional impact (greater than a 50 percent reduction in TVV) is detected, additional mitigation will be provided.

9 The final sampling configuration may be modified depending upon field conditions and the ability to maintain adequate replication for comparative purposes.

10 The jurisdictional drainages that occur below the mine are likely not evenly distributed among the different drainage size classes. Because it is possible that there will be differential response by the vegetation communities within drainages of different size, the analysis of cumulative effect will be weighted proportionately.

The calculation method that will be used to determine the percent change at each transect follows:

TVV_L = Total Vegetation Volume of Living Woody Plant Species
B1 = Transect 1 – Baseline Condition
n1 = Transect 1 – year n

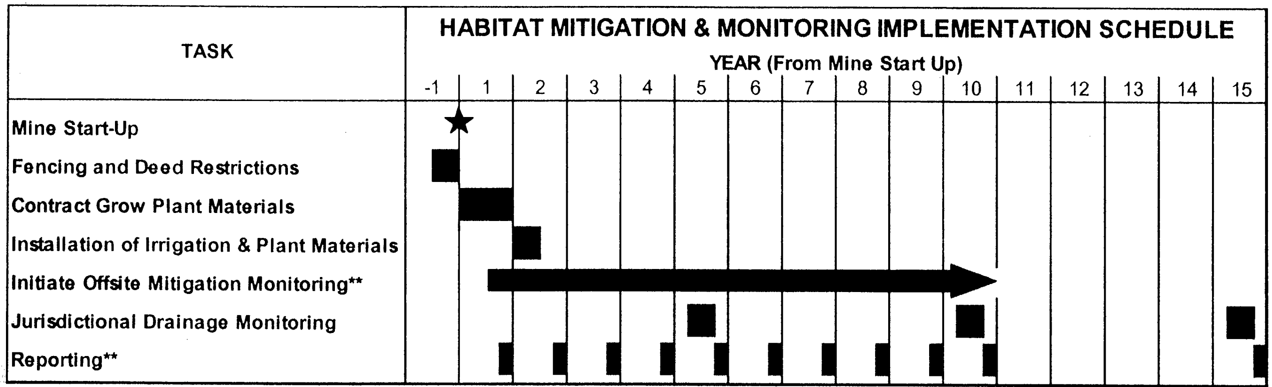
$$100\left(\frac{TVV_{Ln1} - TVV_{LB1}}{TVV_{LB1}}\right) = \Delta_{n1}$$

Δ_{n1} = The percent change in living woody plant material from the baseline condition for transect 1 at year n. A positive number equals a beneficial impact and a negative number equals an adverse effect. To determine average effects downstream of the mine facility, transect changes (Δ_n) are averaged and the variance determined by sampling category to evaluate overall effects and to compare effects by drainage size class and distance below the mine facility. These data are then used to determine the adequacy of mitigation provided and the fifty-percent impact assumption.

2.4. Habitat Mitigation and Monitoring Implementation Schedule

Mitigation and monitoring implementation will be initiated concurrently with project development. Within one year following the initiation of project development, mitigation sites will be fenced and restrictive covenants placed upon the appropriate portions of the offsite mitigation parcels. Contracts for plant materials required for restoration measures will be written and a contractor retained for this work. During the first year of mine start up, initial monitoring efforts of the offsite mitigation areas and baseline monitoring of down gradient jurisdictional waters will be implemented. This will include establishment of permanent photo points and gathering any additional baseline information required to support mitigation implementation. Within two years following the initiation of project development, irrigation systems will be constructed, contracted plant materials will be planted at the designated sites, and monitoring of these plantings will begin. The following graphic (Exhibit 1) is a summary of the mitigation implementation and monitoring schedule.

Exhibit 1. Habitat Mitigation and Monitoring Schedule



**Monitoring and monitoring reporting will continue as needed pursuant to Section 2.2.5.1.

3. WATER RESOURCES MITIGATION

3.1. INTRODUCTION

This section of the Project Mitigation and Monitoring Plan summarizes mitigation proposed to offset the effects of predicted project impacts to water resources. The potential impacts that result from water use required for project development and the effects of development of the Dos Pobres/San Juan mine pits on water resources in the vicinity of the proposed mine project were identified as scoping issues during public scoping efforts for the Project EIS. This aspect of the Plan stems specifically from the scoping and mitigation requirements that arose from implementation of the NEPA process.

Water resources mitigation provided in this Plan is presented as two distinct but interrelated elements. The first is the groundwater model and monitoring program. This program will be used to validate and refine model results through time and, if necessary, determine if additional water mitigation is required. The second element of the mitigation program is a fallow lands agricultural management strategy that will leave water in the Gila River system to protect aquatic and riparian resources and offset predicted impacts to the stream from the Project. Combined, these elements of the mitigation effort are referred to as the Model, Monitor, and Mitigate Program, or 3-M Program. This approach was developed by the BLM's groundwater consultant, Dr. Robert MacNish, and has been adopted by the BLM Interdisciplinary Team. Each of the elements of the water resources mitigation program is discussed in greater detail below following a summary of the predicted impacts of the proposed mine activity to surface water and groundwater resources.

3.2. PREDICTED WATER RESOURCE IMPACTS

3.2.1. Groundwater and Surface Water Impacts

In conjunction with the BLM's consulting hydrologist Dr. MacNish, Dames & Moore (1997a, 1997b, 1997c, 1997d, 1996) prepared a groundwater model to evaluate the potential impact of the Project on the groundwater and surface water regimes near Safford (the Draft EIS [DEIS] Model). The purpose of the model was to predict what impact, if any, there may be on water resources from development of the proposed open pit mines and groundwater production wells. Of particular interest was the potential impact to surface flows in the Gila River, approximately eight miles south of the proposed production well field. Dr. MacNish, the authors of the model, and Phelps Dodge recognized that the DEIS model over-predicted drawdown from the Project as a result of assumptions incorporated into the model and assumptions built into the MODFLOW computer code used to generate the model summarized in the 1998 DEIS. In response to public comments and changes in the mine plan, the DEIS model was revised in November 2001 (the 2001 Model) to reflect a more realistic simulation of the water table and to account for the 20 percent reduction in projected water demand that resulted from revised mine plans.[11] Discussions and technical review by the BLM's and the BIA's groundwater consultants led to several suggestions for improvement of the accuracy of the 2001 Model. As a result, the 2001 Model was revised and is referred to here as the 2002 Model.[12] The 2002 Model incorporated revisions that significantly reduced numerical error that had caused the 2001 Model to over-predict the cumulative volume of impacts to the Gila River.[13]

Except in the immediate vicinity of the mine, and southwest of the Gila River channel, hydrologic information on aquifer parameters and the hydrologic effects of faults are sparse. As a result, calibration of the groundwater model has been accomplished by trial and error adjustment of aquifer parameters within the limits of values reported in the literature for these and/or similar units. In addition, the boundary fluxes in the model were also constrained by data from U.S. Geologic Survey (USGS) stream flow gauges or published estimates of subsurface flows both into and out of the model domain. While the model calibration resulted in acceptable matches of computed and observed water levels in wells, the present model is but one of many unique solutions that might match computed and observed values with equal precision.

In a typical model construction effort, a great deal of effort is usually spent assessing the uncertainties in parameters used in the model, and the resulting uncertainties in model projections. These efforts are undertaken in order to allow the model builder to clearly identify the limitations that subsequent model users must heed in applying new or additional stress to the modeled system, and in estimating the reliability of resulting model projections. In this case, the sparse data outside the immediate vicinity of the mine, and the short six-month period when the aquifers were stressed by pumping in the proposed mine well field would have led to large estimates of uncertainty. This would be particularly true for projections extending for multiples of the duration of the pumping stress used to calibrate the transient model.

Over time, almost the entire amount of the mine's total pumpage that is lost to evaporation at the mine will be subtracted from the flow of the Gila River. Due to the distance between the mine and the river, the large amount of groundwater flow in the system, and the effects of faults on the flow system, this extraction is expected to be spread over many years. The present calibration of the model, the 2002 Model, is projecting a peak impact to the Gila River of 34 acre-feet per year[14] (af/yr) at about model year 450. These modeled impacts do not account for the formation of lakes in the mine pits after mining ceases. If lakes do form, discharge of ground water into them may increase potential impacts to the Gila River. The long-term post-mining groundwater discharge into the modeled pit lakes is predicted to be 21

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[11] URS. 2001. Summary of Revisions to the Draft EIS Ground-Water Flow Model, Safford District, Arizona. Technical Memorandum dated November 30, 2001.

[12] John Korolsky, Phelps Dodge Safford, Inc. Personal Communication with J. Tress WestLand Resources, Inc. 19 August 2002

[13] The authors of the model have indicated that this error resulted from artificial numerical dispersion. Artificial numerical dispersion results from errors introduced by the mechanics of the computations required by any numerical model. These mechanical limitations result from truncation (the result of approximating one equation with another), round off of computer computations, solver limitations, and volume averaging.

[14] Email From P Sinton (URS Corps) to R Mac Nish August 21, 2002

af/yr.[15] A conservative estimate of the total predicted peak impact to the Gila River as a result of the mine's impact on the groundwater system is, therefore, 55 af/yr.[16]

As a consequence of the facility's "zero discharge" design for pollution prevention purposes, the project will cause an estimated net average annual reduction in ephemeral stormwater runoff of approximately 94 acre-feet. The change in runoff was estimated as the difference in runoff between the baseline watershed conditions and the overall runoff reduction under post-project watershed conditions.

The total predicted effect on the river from the calculated net average annual reductions in ephemeral stormwater runoff (94 acre-feet), and predicted maximum groundwater impacts (55 acre-feet) totals approximately 149 af/yr.

The 2002 Model indicates that the drawdown of groundwater levels will cover a much smaller area but will occur over a much longer period than predicted by the DEIS Model. The 2002 Model predicts that any decline in water table elevations beneath the San Carlos Apache Reservation (the Reservation) will be nearly zero, and that impacts to Bonita Creek will be nearly zero as well.[17] The 2002 Model predicts the maximum annual change in groundwater flow southward from, and groundwater storage beneath the Reservation will be about 0.2 af/yr. The peak cumulative temporary reduction in storage of 186 acre-feet is predicted to occur at approximately year 3400.[18] After this period, cumulative impacts decline. Predicted impacts to Bonita Creek are predicted to always be less than 0.1 af/yr over the 3,000 years of model prediction.

3.2.2. Springs, Seeps, and Watson Wash Hot Well

Watson Wash Hot Well is located approximately 6.5 miles southwest of the Dos Pobres Mine. The 2002 groundwater model predicts a possible 0.62-foot peak reduction in wellhead pressure at the Watson Wash Hot Well approximately 280 years after initiation of mine development. (email from Peter Sinton to Dr. Robert MacNish, August 30, 2002). The impact decreases after this peak as the regional aquifer system recovers. Springs near the project area are not expected to be impacted by the proposed development. The Butte Fault appears to isolate these springs from the Graben where groundwater will be pumped for mining purposes, and the springs appear to be fed by locally recharged perched aquifers, and not connected to the regional groundwater system.

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[15] URS. 2001. Summary, Revision of DEIS Model. November 30, 2001.
[16] 2002 Model predicted peak impacts plus the pit lake impacts reported in the November 30, 2001 URS Memo (see note 4)
[17] Email From P Sinton (URS Corps) to R Mac Nish August 21, 2002
[18] Estimated from linear projections of the predicted annual change in storage.

There are a number of springs located north of the Gila River near Bylas that emerge as seeps in drainages exiting the elevated terraces and along the faces of the sloping terraces themselves. Cold Springs and the springs near Bylas are located approximately 13 and 26 miles from the mine, respectively. Cold Spring does not appear as a named spring on the USGS topographic maps, but all the data available for a number of the springs in this area show water temperatures ranging from 66° to 79° Fahrenheit and total dissolved solids in the mid-3,900 ppm range.

The source of the water feeding these springs is primarily local recharge along the Gila Mountain front, as the deeper artesian zones in this basin have temperatures near 100°F. The effects of the mine pumping will not affect shallow aquifers at great distances from the mines' well field, though the pressures in the deeper artesian zones will be affected over a much wider area.

The 2002 Model predicts a 0.62-foot maximum change in artesian pressure in the Watson Wash well, located approximately 6.5 miles southwest of the Dos Pobres mine. Even if some of the water in the springs near Bylas is derived from the deeper pressurized zone, it is not likely that any change in flow would be measurable, as the decrease in pressure in the artesian aquifers would be only a fraction of the decrease in head predicted for the Watson Wash well.

3.2.3. Water Resources Mitigation Requirement Summary

The mitigation requirements established between PDSI, the BLM, and the COE are for the calculated net average annual reductions in ephemeral storm water runoff to the Gila River and the predicted maximum groundwater impact to the Gila River that result from development of the mine, which combined total approximately 149 af/yr. Should the monitoring conducted during mine operations and the resulting recalibration of the model required by this plan result in greater predicted impact to the Gila River, additional mitigation would be provided if predicted impacts exceed the levels of mitigation proposed in the following sections.

The 2002 Model predicts that any decline in water table elevations beneath the Reservation will be nearly zero, with a total temporary cumulative loss in storage of 186 acre-feet.[19] PDSI anticipates that BLM will address potential mitigation requirements, if any, for predicted impacts to groundwater beneath the Reservation in their Record of Decision[20] to be prepared after publication of the FEIS.

3.3. Mitigation Approach

The mitigation approach being utilized to offset predicted effects to the Gila River system is presented in three parts. The first part is the groundwater model and monitoring program, which is designed to determine the efficacy of the groundwater modeling effort and the adequacy of compensatory mitigation

[19] Email From P Sinton (URS Corps) to R Mac Nish August 21, 2002
[20] Presuming that the Record of Decision authorizes one of the Action Alternatives.

provided for water resources. The second part describes monitoring and mitigation steps that will be implemented to minimize predicted impacts to the Watson Wash Well so that they become discountable. The third section describes the compensatory mitigation program which, through alternate year fallowing of selected agricultural lands, will result in a net reduction in water demands upon the Gila River system, considering the combined predicted effects of mine development and the mitigation effort.

Under current law, PDSI may pump groundwater for use at the Project regardless of the effect of its pumping on groundwater levels under adjacent land. Whether this will continue to be the law is the subject of on-going water rights litigation in State and Federal courts. Implementation of the water resources mitigation programs outlined below does not prevent the United States from objecting in the future in the appropriate court to groundwater pumping for the Project if the United States believes such pumping interferes with water rights owned by the United States or held by the Unites States in trust for Indian tribes.

3.3.1. Groundwater Model and Monitoring Program

Because of the uncertainties associated with the model, as well as the uncertainties of specifying the spatial and temporal distribution of pumping in the mine well field over a 16-year projected life of the mine, a program was designed to monitor the performance of the model in simulating the effects of actual pumpage on an annual basis. These monitoring data will be used to first determine if model re-calibration is required and then used to update and refine model input parameters used in the re-calibrated model. A network of 37 existing wells (Table 9) and up to 13 additional planned wells (Table 10) have been identified for comparison of measured water levels with model-projected water levels in the model cells. Criteria were established to compare observed and model projected water level changes in these wells, as well as changes in the slope of the groundwater surface between pairs of the planned Group 1 wells.

As the volume of water extracted by the mining operation increases, the aquifer near the mine will be stressed. Changes in the water levels in monitoring wells, when compared to model predictions, will provide a means to better define aquifer parameters, the reasonableness of estimated boundary fluxes, the effects of model structure and assumptions on the model performance, as well as the hydrologic effects of any faults. Thus, over the duration of the mining operation, the uncertainties associated with the model parameters, and the resulting uncertainties in model projections will diminish. At the end of mining, estimates of model uncertainties can then be made to assess the reliability of the projected recovery of the system from the mining operation.

When any of the threshold criteria established in this MMP are exceeded, a re-calibration of the model will be initiated. This re-calibration must satisfactorily replicate the entire historical record of water level changes since the onset of mine pumping even if re-calibration requires changes in model boundary conditions and structure. If re-calibrated model predicts groundwater impacts in excess of those currently predicted by the model, the adequacy of existing mitigation will be reviewed and, if necessary, additional mitigation for groundwater impacts provided as outlined in this plan.

Five groups of wells (Well Groups 1 through 5; Table 9 and 10) will be used to monitor groundwater in the project area and gather data to recalibrate the model as needed. Well Group 1 and Well Group 5 will be comprised of new wells constructed to monitor groundwater system response to groundwater pumping and mine construction. Group 1 wells will be located between the mine and the Gila River. Two Group 5 wells will be located between the mine and the Reservation and a third Group 5 well will be located between the mine and Bonita Creek. Groups 2, 3, and 4 wells have been installed and several measurements have been obtained from each. For Well Groups 2 and 3 the well construction is known, and the wells are open to a relatively small vertical section, usually equivalent to one model layer. Group 3 wells were split from Group 2 wells because they are not required for evaluating whether or not to recalibrate the model, though data from these wells will be useful in any required recalibration effort. Group 4 wells are existing wells located between the mine and the Reservation and were selected to monitor groundwater system response between the mine and the Reservation.

3.3.1.1. Monitoring Well Construction

A minimum of nine new monitoring wells will be constructed. Six monitoring wells will be located between the mine and the Gila River (the Group 1 wells) and two will be located between the mine and the Reservation and one between the mine and Bonita Creek. The latter three wells will comprise the Group 5 wells.

The most permeable aquifer between the mine and the Gila River is the Lower Basin Fill (Dames & Moore, 1997e). If the model's present configuration either over- or under-represents flow moving from the mine area toward the river, the signal (a growing disparity between model projected and measured water levels in wells) will be most apparent in this aquifer. Layer 9 and Layer 10 of the model have a sufficiently extensive area comprised of Lower Basin Fill (LBF) in a broad northwestward trending swath between the mine and the Gila River to satisfy the monitoring objectives. Group 1 wells will be constructed as two-well transects within a model column (a Column Transect) in the LBF. Each Column Transect will be located along approximately the same flow line of the aquifer and as close to the center of the selected model cell as possible.[21] Paired (deep and shallow wells) will be constructed at one of the Column Transects. For the purposes of this project, spacing between the primary wells within each Column Transect along the flow line is expected to be 3850 feet. The ability to measure riverward gradients in the LBF and possibly in the volcanics, as well as vertical gradients between the two geologic units, or at a minimum within the LBF aquifer, will provide valuable information to be used in any required model re-calibration.

[21] Because the water levels computed by the model represent the average value of the entire model cell, it is best to locate any monitoring well as near the center of a model cell as possible, particularly if the model cell is large in either or both horizontal dimensions. If two wells are constructed approximately along a flow line of the aquifer, disparities in changes between computed and observed gradients can be easily determined.

Table 9. Dos Pobres/San Juan Project Monitoring Well Network. Existing Wells to be Measured at Periodic Intervals

Well Group	Well I.D.	UTM NAD 27 Coordinate Easting	UTM NAD 27 Coordinate Northing	Layer(s)	Surface Altitude	Open Interval	W.L. Elevation	Date Measured
Group 2	AP-11	621659.80	3646041.72	10	3680	2891-2841	3158	2/98
	AP-12	622593.04	3646442.51	8	3798	3239-3189	3265	3/98
	AP-20	625486.39	3645582.91	9	4041	3114-3054	3529	12/30/97
	AP-22	623034.16	3644823.09	9 & 10	3669	3017-2917	3034	3/11/98
	AP-23A	624758.43	3644492.61	9	3757	3001-2951	3033	6/17/96
	AP-24	625572.71	3644430.50	8 & 9	3835	3195-3095	3211	12/30/97
	AP-26	623748.62	3643812.88	9	3645	3026-2976	3024	2/12/98
	AP-27	621869.26	3643120.52	9 & 10	3414	2985-2935	3029	3/9/98
	AP-28	623109.22	3642671.39	9 & 10	3474	2965-2915	3030	12/30/97
	AP-29	624494.83	3642738.48	9 & 10	3501	2984-2934	3027	1/15/98
	AP-30	626351.69	3643695.78	6	3501	3575-3525	3755	2/11/98
	AP-34	621469.21	3644272.94	13	3487	2337-2287	3032	8/8/97
	DPW-1	620694.56	3646901.24	8 & 9	3697	3135-3085	3196	3/10/98
	DPW-3	623970.85	3644848.62	9 & 10	3839	3037-2927	3036	3/11/98
	DPW-7	620520.97	3645287.70	10 & 11	3508	2830-2780	3028	3/9/98
	DPW-8	619238.87	3642864.50	10	3217	2909-2874	3028	3/9/98
	DPW-10	616501.01	3645082.58	11	3247	2710-2680	3025	3/10/98
	DPW-11	617840.36	3644467.12	10	3273	2930-2900	3024	3/10/98
	DPW-12	616438.58	3643456.31	12 & 13	3094	2484-2444	3018	3/9/98
	DPW-13	617784.50	3642885.79	11 & 12	3144	2633-2603	3021	3/9/98
	DPW-15	622743.74	3644015.92	10 & 11	3572	2807-2777	3029	2/12/98
	DPW-16	621509.81	3644273.76	11	3490	2720-2690	3034	3/9/98
Group 3	AP-1	623003.74	3648865.07	5 & 6	4166	3669-3558	3887	2/11/98
	AP-2	623711.15	3648413.55	4	4166	3887-3837	4090	12/29/97
	AP-3A	625402.68	3648652.38	4	4493	3913-3863	3915	8/8/97
	AP-9	625440.15	3647652.36	3	4370	4238-4188	4293	2/18/98
	AP-10	626319.30	3646930.50	7	3930	3441-3391	3915	12/30/97
	AP-21	626441.34	3645352.56	4	4087	3830-3780	3848	1/21/98
	AP-25	625835.28	3645017.27	5	3917	3663-3603	3905	1/19/98
	AP-32	625033.51	3647405.38	5	4183	3777-3727	3888	12/30/97
	DPW-5	624490.57	3648434.81	9 & 10	4292	2967-2917	3834	3/11/98
	DPW-6	625785.64	3647017.22	6 & 7	4160	3459-3409	4067	2/5/98
Group 4	GI-T18	620504.6	3649963.41	9 thru 15	4210	2974-2596, 2486-1709	3309	08/27/97
	GI-T20	621208.94	3650441.74	4 thru 10	4300	3808-3208 3128-2828	3823	08/27/97
	GI-T25	621998.90	3649665.83	3 thru 9	4335	4135-3015	4109	10/09/97
	GI-T34	619686.60	3648858.32	7 thru 14	3924	3297-1435	3257	11/05/97
	GI-T38	619681.80	3651329.14	4 thru 14	4372	3873-2454, 2160-2017	3831	11/16/97

Table 10. Group 1 (Lower Basin Fill) and Group 5 Well Monitoring Network, Dos Pobres/San Juan Project

Well Identifier	UTM NAD 27 Coordinate[1]		Model Cell[2]		Alsd[3]	Depth[3]	Screened Interval[3,4]		Model Layer[4]		Water Level Elevation[3]
	Easting	Northing	Row	Column			Top	Bottom	Unit	#	
GROUP 1 Wells											
LBF–01	620059.99	3644737.81	83	42	3380	450	3050	2930	LBF	9	3030
LBF–01D[5]	620059.99	3644737.81	83	42	3380	950	2530	2430	LBF	12	3030
LBF–01 ALT[6]	619845.77	3644402.61	84	42	3345	415	3050	2930	LBF	9	3030
LBF–02	619425.69	3643745.29	86	42	3260	335	3045	2925	LBF	9	3025
LBF–02D[5]	619425.69	3643745.29	86	42	3260	835	2525	2425	LBF	12	3025
LBF–03	622374.68	3643258.55	83	74	3410	480	3050	2930	LBF	9	3030
LBF–03 ALT[6]	622160.47	3642923.35	84	74	3380	450	3050	2930	LBF	9	3030
LBF–04	621740.39	3642266.03	86	74	3280	355	3045	2925	LBF	9	3025
LBF-05[7, 8]	617867.27	3646139.12	83	20	3440	510	3050	2930	LBF	9	3030
LBF-06[7]	617232.97	3645146.60	86	20	3300	304	3045	2925	LBF	9	3025
LBF-07[7]	623871.60	3641355.76	85	89	3330	399	3050	2930	LBF	9	3030
LBF-08[7]	623439.31	3640679.31	87	89	3280	355	3045	2925	LBF	9	3025
GROUP 5 Wells											
G5-01A[9]	621235.52	3655301.47	16	22	5250	830	4500	4420	Ka	2	4400
G5-01B[9]	621576.67	3652466.61	19	28	4800	1080	3800	3720	Ka	4	3700
G5-02	631940.78	3645252.20	109	29	4300	430	3950	3870	Ka	4	3950

1 UTM Coordinates are at the center of a model cell. Conditions encountered in drilling may result in some dislocation from model cell centers.

2 Row number 1 is at the northern edge of the model and column 1 is at the western edge of the model.

3 Elevations of land surface, water levels and the depths of wells are estimated from topographic or model data. All elevations and depths are approximate and exact depth and screen location depends on the elevation of the water table encountered during drilling. ALSD is Altitude of Land Surface Datum

4 If shallow wells are finished in layer 10, they will be 164' deeper, and the screened interval will be from about 2,950 to 2,790 elevation.

5 The "D" in LBF-01D and LBF-02D indicates a separate well at the same location but screened deeper.

6 The "ALT" indicates alternate locations for LBF-01 and 03 which are only drilled if the Tv unit is encountered when there is less than 100 feet of saturated thickness of LBF in LBF-01 or 03. The original well will be abandoned.

7 LBF-05 and 06 would be drilled only if clay occupies more than 30% of the screened intervals of either LBF-01, LBF-01 ALT or LBF-02. Similarly, LBF-07 and LBF-08 would only be drilled if clay occupies more than 30% of the screened intervals of either LBF-03, LBF-03 ALT or LBF-04.

8 If LBF-05 is drilled as a replacement for LBF-01, then its location will be as shown on the table (Row 83, Column 20). However, in the event LBF-05 is drilled as a replacement for LBF-01 ALT, its location will be moved down one row to the center of the cell in Row 84 and Column 20.

9 If at some point in the future, due to circumstances beyond PD's control, these wells are not accessible for monitoring, PD will work to find suitable replacement in the vicinity aceptable to the USGS and the COE.

One set of the Group 1 Column Transect wells will be drilled as paired (deep and shallow) wells (the Paired Wells) resulting in a total of four wells for that Column Transect. The screened interval (openings) in the shallow well will extend from 20 feet above the water table to 100 feet below, and the top of the one hundred foot screened interval of the deeper well will be 500 feet below the bottom of the screened section in the shallow well. The deeper wells may be in the underlying volcanic rocks.

The Group 1 wells will be equipped with instrumentation capable of recording water level data on daily intervals.

If the shallow wells encounter clay equivalent to 30 percent or more of the thickness of the screened section, an additional well pair will be constructed. The number of constructed (Group 1) Column Transects will not exceed four. The recommended locations of the wells are at or near the cell centers of model cells in rows 83 and 86, columns 42 and 74. If a thick clay layer, as defined above, is encountered in either column 42 or 74 well pairs, then additional well pairs will be required in column 20 and 89, respectively. The wells in row 86, LBF-1 and LBF-3, (and LBF-5 and LBF-7, if necessary) should be drilled before the wells in row 83 because the wells in row 86 are the most likely to encounter clay.

Figure 10 shows the locations of the primary Group 1 well pairs as well as the alternate locations that may be required because of conditions encountered during drilling. As conditions encountered during drilling affect the number and locations of wells, a guide for the drilling sequence has been prepared (EXHIBIT 2).

The casing/screen diameters and materials used to construct the well are not critical, as long as they are sufficient to permit development of the well to assure good connection with the aquifer after construction. Because the LBF is expected to be unconfined in this area, no special packing and sealing (other than a good surface seal) is necessary on the shallow Group 1 wells, but if the deep wells on the Column Transect wells are finished in the volcanics, a seal will be required between the LBF and the volcanics.

Monitoring the water levels in the group 3 and 4 wells will provide early indication of discrepancies in model projections in the direction of the Reservation. To enhance monitoring coverage, two additional wells will be drilled in closer proximity to the Reservation boundary, one in the SE ¼ of Township 5 South, Range 26 East, Section 8, and the other in the NW ¼ of Township 5 South, Range 26 East, Section 5 (Group 5 Wells). A third Group 5 Well will be installed between the Project and Bonita Creek, near the center Township 6 South, Range 27 East, Section 4. These wells will be constructed to penetrate the water table to a depth of 100 feet and screened for a minimum of 100-feet below the water table, as the potential drawdown of the water table is the most important possible impact resulting from the mine pumping.

EXHIBIT 2. Group 1 Wells, Drilling sequence.

1 Drill in the center of Row 86, Column 42 to 600' below the water table, screen the bottom 100 feet unless volcanics are penetrated, in which case leave open hole in the volcanics, and seal off connection to the LBF. [LBF-02D (deep)]

2. Drill a second well at this site to penetrate 100 feet below the water table and screen the well from 20 feet above the water table to the bottom of the well. [LBF-02 (shallow)]

3. Drill a well in the center of Row 83, Column 42. [LBF-01 (shallow)] If volcanics are encountered when there is less than 100 feet of saturated LBF, abandon this well and drill in the center of Row 84, Column 42. [LBF-01 ALT (shallow)] Drill and complete well as in #2 above.

4. Drill a second well in the center of the same Row and Column that the shallow well in #3 above was completed in to the same specifications as the well in #1 above. [LBF-01D (deep)]

5. If clay layers total more than 30 percent of the saturated thickness within the screened interval of the wells drilled in #2 or #3 above, drill two additional wells to the same specifications as #2 above in the centers of Column 20 in the same row that the well in #3 above was completed in and in Row 86 of Column 20. [LBF-05 and LBF-6]

6. Drill a well in the center of Row 86, Column 74 to the specifications of the well in #2 above. [LBF-04]

7. Follow the same procedure as in #3 above, to drill a well in either Row 83 or 84 in Column 74. Finish this well as done in 2 above. [LBF-03 or LBF-03 ALT]

8. If clay layers total more than 30 percent of the saturated thickness within the screened interval of the wells drilled in 6 and 7 above, drill two additional wells to the same specifications as #2 above in the centers of cells in Row 85 and in Row 87 of Column 89. [LBF-07 and LBF-08] (More southerly rows are selected for this well pair because the boundary between the volcanics and the LBF shifts to the south in the eastern part of the area.)

** Regarding well location, it is important to maintain row location. Column location may be moved one higher or one lower to accommodate drilling conditions.

3.3.1.2. Data Acquisition

3.3.1.2.1. Sampling Frequency

Tables 9 and 10 list wells in the mine area whose water levels will be measured on a periodic basis after mining begins. To provide the best information with which to perform any necessary model recalibration, water level measurements will follow the schedule outlined in Table 11.

As the project progresses, water level monitoring and other data collection activities will provide information and insights on which to base a sound post-project monitoring plan. Within three years of the end of mining operations at the site, PDSI will formulate a post-operation monitoring plan with input from USGS and other members of the stakeholders committee. The plan will be submitted, along with USGS review and public comments, to the COE. The plan will specify the number and frequency of groundwater levels to be measured, any other monitoring deemed necessary, and the need for future model calibrations. The plan will provide a mechanism for determining when all monitoring may be discontinued.

Table 11. Groundwater Well Water Level Monitoring Schedule

Well Group ID	Years of Monitoring Required Prior to Mining	Sampling Frequency				
		Pre-Mining Monitoring Period*		Mining Period		Post Mining
		Year 1	Year 2 to Mine Start-up	Year 1	Year 2-16	
1	Minimum of One Year**	Daily	Daily	Daily	Daily	TBD***
2	Two Years	Monthly	Quarterly	Monthly	Quarterly	TBD
3	Two Years	Monthly	Quarterly	Quarterly	Quarterly	TBD
4	Two Years	Monthly	Quarterly	Quarterly	Quarterly	TBD
5	Minimum of One Year***	Monthly	Quarterly	Quarterly	Quarterly	TBD

* If baseline monitoring data collection is discontinued the minimum number of years of monitoring will have to be collected again prior to commencement of mine operations.

** Instrument as soon as drilled; monitoring to commence after well construction through the remaining monitoring period for a minimum of one year.

*** Within 3 years of the end of mining operations at the site, PDSI will formulate a post-operation monitoring plan with input from USGS and other members of the stakeholders committee.

3.3.1.2.2. Equipment Calibration and Quality Assurance

Quality assurance for the data acquisition will include periodic equipment calibration checks made by Phelps Dodge or their contractor with oversight provided by the USGS, and an annual check measurement made by USGS in concert with the measurements being made by Phelps Dodge or their contractor. The check measurement should coincide with the annual round of measurements of the Group 4 and 5 wells. In addition, USGS personnel will measure ground-water levels at selected project wells twice per year as a quality control check on measurements made by PDSI or their contractor. In general, water level measurements should be made in accordance with the American Society for Testing and Materials (ASTM) Method D 4750 for "Determining Subsurface Liquid Levels in a Borehole or Monitor Well (Observation Well)" (Appendix D). This method describes in detail the procedure needed to obtain a water level measurement. The ASTM method specifies that calibration of the instrument should be done in accordance with the manufacturer's recommendations. The following paragraph describes the general approach that should be used to calibrate water level measuring devices for this project.

Prior to its first use in the field, the total depth of the electric measuring device (sounder) and the accuracy of intermediate marks at 25-foot intervals should be checked in the office using a specially designated ¼-inch wide, 500-foot steel tape. This ¼-inch wide steel tape is to be designated as a reference tape and used only to calibrate the measuring devices used in the monitoring program At the beginning of each water level measurement round, the sounder used to measure water levels in wells will be calibrated by means of a check measurement made using the specially designated ¼-inch wide, 500-foot steel tape. . Check measurements should agree to within 0.02 feet per 100 feet of water-level depth. If the instrument fails the calibration-check it will be repaired or replaced before use. Calibration will be done at a selected well that has: 1) a large depth to water and 2) a relatively large diameter such that suspended cables and tapes will not become tangled and hung up in the well. At a well where the depth to water exceeds 500 feet, independent measurements will be made with different instruments. These measurements should agree to within 0.02 feet per 100 feet of depth.

Each Group 1 well should be visited monthly to check the water level by sounding with a steel tape or electric sounder. This will ensure the equipment is operating properly and that data from instrumentation in the well is captured. This monthly round of data collection during the pre-mining period may include measurements at additional wells in the area and in wells between the Butte and Valley faults.

3.3.1.2.3. Measuring Points (MPs)

Each well for which water level measurements are to be made will have a clearly identified MP. A "V" cut with a file on the well casing or on the edge of a hole in the well cap or port leading into the well bore will be made at every well to be measured. Monuments of known elevation will be established and the elevations of the MPs will be leveled in. One monument may be used as the reference datum for several wells.

Two photographs should be taken of each well, one at a distance of 1 to 2 meters that clearly shows the MP, and one at a distance of approximately 10 meters, to show the well and its immediate surroundings. Both photos (or copies thereof) will be compared with conditions at each well during each measurement, and changes that could potentially affect the MP elevation will trigger a re-leveling in of the MP. In addition to the photos, the observer will have a graph showing previous measurements, plotted against time.

3.3.1.2.4. Water Level Measurement

The procedures described in ASTM Standard Method D 4750 will be used to obtain water level measurements. Water level measurements will be made by recording all data used in computing the elevation of the water level. For example, if a steel tape were to be used, the mark on the tape "held" at the MP will be recorded, and the "cut" (the uppermost completely wetted part of the steel tape representing the water level being measured) will be recorded. A check measurement will be made, with the data recorded, and if differences in the depth to water between the two measurements are in excess of 0.02 feet per 100 feet of depth to water, additional measurements will be made until two subsequent measurements are within those ranges. All data observed, regardless of the number of measurements required to satisfy the conditions specified above, will be recorded. The reported water level will be the average of the two final measurements that fall within the range of variation.

In the event that the measuring device becomes "stuck" and must be dislodged with a hard jerk, or the measuring device hangs up and coils up within the well bore, the measurement notes must record the event in the case that the measurement device calibration has been affected. In such a situation, a recalibration should be done as soon as the measurement round has been completed, and any required corrections shall be applied to the measurements made after the measurements where the problem occurred.

3.3.1.3. Data Analysis

Annually, water level data from each LBF monitoring well should be averaged for each month and the drawdown computed from the last monthly average water level for that well, and the water level in that well at the time of the most recent model calibration. The observed drawdown is then compared with the modeled drawdown over the same period. Figure 11 illustrates the groundwater model and monitor process.

All evaluations are made annually, and the period of each analysis is from the date of the most recent model calibration to the current date. These evaluations are made with the actual pumping stress over that period of time entered in the model, accompanied by any changes in plans for pumping in subsequent years. The model results will then reflect the effects of actual pumpage up to the current year, as well as out-year projections that may affect mitigation measures.

Exhibit 3 describes the procedural details for computing the values used in Figure 11. The values shown on Figure 11 that are used as recalibration triggers in the Groundwater Model, Monitor, and Mitigate Program have the potential to trigger periodic recalibration efforts if substantial changes in the model are required after mine pumping reveals more information on the hydrologic conditions at the site. For this reason, unless changes identified in Figure 11 are more than double those shown, model recalibration should not be made until three years of mining operation have elapsed since the most recent model calibration. This will allow the acquisition of sufficient data to recalibrate the model to the point that frequent recalibration may not be required over the life of the mine operation.

If average water levels in the monitored Group 1 well pairs (after recovery from drilling and well development) differ by more than 30 feet[22] from the corresponding average projected steady-state model water levels, or the gradients between wells along any flow line differs by more than 25 percent from the model's steady-state simulation during the pre mining monitoring period, model calibration should be adjusted to bring the projected levels and gradients within those bounds.

If such recalibration is necessary, then the mining impact projection should be re-run to determine whether any modification to the mitigation measures is needed.

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[22] The mean error for model-projected water levels in wells in this vicinity.

Exhibit 3. Evaluation of Groundwater Level Data for Comparison to Groundwater Model Predictions

Introduction:

This document describes the specific steps to follow in processing the water level data obtained from wells in the vicinity of the Dos Pobres/San Juan Mine area before and during mining operations. In this documents, underlined items are used in the calculation of critical values used in the decision process outlined in Figure 11 of this report. The critical values used in Figure 11 are shown in bold-face type.

Pre-mining Monitoring Program:

Prior to the onset of mining operations, and before any significant pumping begins in the vicinity of the mine, the Group 1 (LBF) wells need to be drilled, and data recorders and stage sensors installed to obtain background water level data prior to the beginning of pumping stresses. At the time mining operations begin, compute pre-mining average water levels for each Group 1 (LBF) well by averaging daily water levels for each well for a minimum of one year prior to mine start-up. The pre-mining monitoring program should be a minimum of two years in duration for Group 2, 3, and 4 wells and one year for Group 5 wells. Group 2, 3, 4, and 5 wells should be monitored monthly for the first year and quarterly for the second and subsequent years prior to mine start-up. In addition, for each Group 1 well, determine the **annual pre-mining water level fluctuation** observed during the pre-mining period by calculating the difference between the highest and lowest water level elevations in each well during the last 12 months of the pre-mining period.

Model Monitor, and Mitigate Program:

The following steps guide the annual processing observed and model-projected data on water levels in specific wells and the model cells that represent those wells. Values determined in the steps below are used in the recalibration decision process presented in Figure 10 of this document. The reader should review the grouping of wells presented in Tables 9 and 10 prior to processing the data.

Group 1 (LBF) Wells:

1. At the end of each annual elevation period, determine (A) the <u>average monthly water level elevation</u> in each Group 1 well for the last month in the evaluation period. After re-running the model and actual pumping rates over the evaluation period, determine (B) the model-projected water level elevation for the same month in each model cell representing a Group 1 well.

2. Subtract the <u>average monthly water level elevation</u> computed in step 1(A) above from the observed water levels in the same well at the time of the most recent model calibration[1] for each Group 1 well to compute the **observed drawdowns since the previous calibration**. Subtract the model-projected water level elevations determined in step 1(B) above from the <u>model-projected water level elevations</u> for those same cells at the time of the most recent calibration to compute the **modeled drawdowns since the previous calibration**.

3. Compute the observed gradient for each Group 1 well pair (e.g., LBF-1 and LBF-2) by subtracting the average monthly water level elevation computed in step 1(A) above for the well closest to the Gila River from the corresponding value for the well farthest from the river to determine the <u>difference in water level in the well pair.</u> This value is then divided by <u>the horizontal distance between the two wells in the pair</u> to obtain the <u>observed gradient</u>. The <u>change in the observed gradients</u> is then computed by dividing the observed change in gradient since the previous calibration by the observed gradient at the previous calibration and multiplying the result by 100.

4. Compute the <u>model-projected gradient</u> for each model cell pair representing an LBF well pair by subtracting the <u>model-projected water level elevation</u> determined in step 1(B) above for the cell in the model closest to the river from the corresponding value determined in step 1(B) for the cell in the model farthest from the river. The <u>difference in model-projected water levels in the two cells</u> is then divided by the <u>horizontal distance between the two cell centers in the pair</u> to obtain the <u>projected gradient</u>. The <u>change in model-projected gradient since the previous calibration</u> is calculated by subtracting the current gradient value from the <u>projected gradients</u> is then computed by dividing the model-projected change in gradient since the previous calibration by the model-projected gradient at the previous calibration and multiplying the result by 100.

5. For each Group 1 well pair, compute the **difference between the percentage changes of the observed and model-projected gradients** over the evaluation period by subtracting the modeled percentage change in gradient computed in step 4 from the observed percentage change in gradient computed in step 3.

[1] For the first evaluation period, use the mean annual water level for each well that was determined in the Pre-mining Monitoring Program.

Exhibit 3. Evaluation of Groundwater Level Data for Comparison to Groundwater Model Predictions (continued)

Group 2 Wells:

6. For each Group 2 well, use the most recent water level measurement as the observed value. Subtract this value from the water level for that well at the time of the most recent model calibration[2] to obtain the observed drawdown for each well.

7. Use model-projected water levels at the time of the measurements used in step 6 for each cell representing a Group 2 well, and subtract these values from the model-projected water levels for the same cells at the time of the last model calibration to obtain model-projected drawdowns for each Group 2 cell[3].

8. Compute the absolute difference between the model-projected and observed drawdown for each cell representing a Group 2 well. Divide the results obtained for each well by the observed drawdown for that well, and multiply by 100 to compute a percentage difference.

9. Sum all the values computed in step 8, and divide by the number of Group 2 wells for which data was available to obtain the **mean value** of the percent difference between model-projected and observed drawdowns.

Group 4 & 5 Wells:

10. Follow the same procedures for Group 4 and 5 wells as in steps 6 and 7 above for the Group 2 wells. Compute the absolute difference between model-projected and observed drawdowns since the last model calibration for each Group 4 and 5 well. Sum the absolute difference for all Group 4 and 5 wells and divide by the number of wells in Group 4 and 5, respectively, for which data were available to obtain the **average absolute difference** for each well group.

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[2] For the first evaluation period, use the latest Pre-Mining water level for each well.
[3] For cell locations with wells open to more than one model layer

In the event a recalibration of the model is required, the recalibration process must include:

1. Documentation of all changes made during recalibration, and an evaluation of the recalibrated model based on graphs comparing model-projected water levels with observed water levels in all Groups 1 through 5wells for the period from start of mine pumping to the most recent annual measurement.

2. A revised model projection run starting at the onset of mine pumping and continuing 3,000 years in the future (or until steady-state conditions are encountered, whichever comes first).

3. A statement of any required changes in mitigation measures with respect to impacts on the Gila River, including the specific action to be taken.

4. A technical adequacy review by the USGS of all recalibration documentation and the recalibrated model projection. The documents described in 1 through 3 above and the USGS review will be incorporated in a report to be submitted to the COE and made available to any interested parties.

3.3.1.4. Water Chemistry Evaluation

Samples from springs and wells in the vicinity of the mine will be analyzed for common ions, trace metals, and isotopes in the late fall one year prior to mine operation to establish a baseline data set, and to provide additional information to improve the conceptual model of the flow system. Wells and springs that are determined to be connected to the regional aquifer system should be sampled annually for two years and biannually until year six of mine operation. If there are no significant changes in water chemistry, sampling can be discontinued. If significant changes are noted, biannual sampling should continue through the life of the mine. The local nature of the source waters for seven springs found within the region will be confirmed by isotopic means to ascertain the age of the water. Recently recharged waters would indicate local origin, while waters derived from the regional aquifer may be hundreds to thousands of years "old".

Table 12 lists the isotopes that will be sampled to determine connectivity of selected springs and wells to the regional groundwater system. Table 13 lists the chemical and physical constituents that will be monitored following the sampling protocols outlined below. Tables 14 and 15 identify the springs and wells, respectively, that will be included in these sampling efforts.

Sampling for groundwater and springs will conform to the guidelines established by the ADEQ's *Quality Assurance Project Plan* (Arizona Department of Environmental Quality, 1991) and the *Field Manual for Water Quality Sampling* (Arizona Water Resources Research Center, 1995).[23] The analytical laboratory to be selected will use approved EPA methods. If data is to be stored in USGS NWIS database, the laboratory will require approval by USGS Branch of Quality Systems.

Flow measurements will be made at all of the springs listed in Table 14 during water quality sampling events. Due to the diverse nature of springs and seeps in the project area and the expected variation in discharge volume due to climatic events, a single sampling procedure will not work for all sites and may not work at a given site at different times of the year. Spring discharge sampling will be accomplished using the best, practical technical method available. Sampling procedures will be clearly documented in field notes and annual reports. Springs and sampling methods will be documented using photographs at each sampling event to clearly illustrate the nature and relative quantity of discharge and to illustrate the sampling procedures used.

Table 12. Isotopes to be sampled at sites listed in Tables 14 and 15

Isotope	Rationale for implementing.
Deuterium, Oxygen-18	Identification of sources, mechanisms of recharge
Tritium	Indicator of young ground-water
Strontium-87	Indicator of water-rock interaction
Carbon-14	Ground-water age indicator, information on transport times.
Carbon 13	Needed for calculation of C-14 age dates.

[23] Arizona Department of Environmental Quality, 1991, Quality assurance project plan: Phoenix, Arizona, Arizona Department of Environmental Quality, Water Quality Standards Unit, 209 p.
Arizona Water Resources Research Center, 1995, Field manual for water-quality sampling: Tucson, Arizona, University of Arizona College of Agriculture, 51 p.

Table 13. Recommended Minimum Reporting Limits (MRLs) for field parameters, and major and trace constituents

Field parameters	Recommended MRLs (mg/L, except where noted)
Water Temperature	NA
PH	NA
Specific Conductance	1 micromho/cm
Alkalinity	5
Carbonate	5
Bicarbonate	5
Dissolved Oxygen	0.1
Major Constituents	
Calcium	0.1
Magnesium	0.5
Sodium	0.5
Potassium	1.0
Chloride	5.0
Sulfate	1.0
Fluoride	0.1
Silica	0.5
Aluminum	0.015
Antimony	0.005
Arsenic	0.005
Barium	0.01
Beryllium	0.005
Cadmium	0.001
Chromium	0.01
Copper	0.01
Iron	0.01
Lead	0.001
Manganese	0.002
Mercury	0.0002
Nickel	0.05
Selenium	0.005
Silver	0.001
Thallium	0.005
Zinc	0.02

Table 14. Spring Isotope, Chemistry, and Flow Sampling Locations.

Spring Name	Location
Bryce Spring	T5S, R26E, S21
Hackberry Spring	T5S, R26E, S27
Walnut Spring	T5S, R26E, S26
Cottonwood Spring	T5S, R26E, S27
Pothote Spring	T5S, R27E, S7
Big Spring	T5S, R26E, S5
Bear Spring*	T5S, R26E, S25
Cub Spring**	San Carlos Apache Reservation
Bonita Spring**	San Carlos Apache Reservation

* Bear Spring is not the same as the Bear Spring located on the San Carlos Apache Reservation.
** Cub and Bonita Spring will be included in the water chemistry and flow sampling efforts if permission to access these springs is provided by the San Carlos Apache Tribe.

Table 15. Wells to be Sampled for Water Chemistry

Well Location/Name	Sampling Period		Remarks
	Baseline	Project	
North of Butte Fault			
AP1	X	X	NE of Butte fault
DPW6	X	X	
AP9	X	X	
AP21	X	X	
AP25	X	X	Isotopes only (chemistry sampled as part of APP)
In Graben			
AP5	X	X	
AP14	X	--	Replaced by Leach-Pad APP wells after project startup
DPW2			
South of Valley Fault			
AP11	X	--	Replaced by Leach-Pad APP wells after project startup
AP22	X	--	Replaced by Leach-Pad APP wells after project startup
DPW1	X	X	
AP23	X	X	
AP26	X	X	
South of Southwest Fault			
AP27	X	X	
AP29	X	X	

3.3.1.5. *Role of United States Geologic Survey*

The USGS has played an important role in the review and technical comment of the water resources mitigation element of the Plan, particularly in regards to the Ground Water Modeling and Monitoring Program (Section 3.3.1). Provisionally and subject to their final approval, USGS will have a long-term role in this process. The specific work elements that we foresee their assistance with are listed below.

- Ground-water levels – Prior to inclusion in the NWIS database, USGS will take part in an inventory of wells and springs. USGS personnel will provide quality control by independently measuring ground-water levels at selected project wells twice per year as a quality control check on measurements made by PDSI or their contractor.
- Water Chemistry – USGS personnel will train/observe PDSI or their contractor with water sampling. USGS will obtain sample splits at five wells during each sampling trip for submittal to USGS National Water Quality Laboratory. The laboratory to which PDSI samples are sent will be approved by the USGS Branch of Quality Systems.
- Database – USGS will perform the following database-related tasks: Code and check well schedules, and enter well information into GWSI (groundwater part of NWIS) (FY 2003 only). Enter groundwater levels into GWSI. Enter groundwater pumpage into NWIS. Perform routine database maintenance. Enter water chemistry analytical data into QWDATA. Review and perform Quality Control checks on analytical results. Enter transducer data into NWIS.
- Reporting – USGS will perform technical review of annual data report prior to submission to the COE. If the model is re-calibrated, USGS will review reports documenting model re-calibration prior to submission to the COE. The USGS technical review will be provided to the COE and made part of the public record. The USGS will attend Stakeholder holder meetings to discuss technical issues as appropriate.
- Web Site – USGS will, through the procedures established above, assure that project data provided to the public through a suitable web page will meet applicable quality control standards. As deemed appropriate, reports and meeting notes may be posted to the USGS project web page, or posted on a PDSI web page linked to the USGS web site.

3.3.1.6. *Expectations*

To put bounds on the expectations of the amount and timing of monitoring and recalibration efforts, it can be conjectured that the connection between the mining area and the river might be substantially better than the present model simulates (i.e., the Valley fault is more permeable). If this is indeed the case, the first re-calibration might occur in the third or fourth year after the beginning of mining. Because the effects of the mine pumping, even with a higher permeability Valley Fault, will take a year or so to reach the monitoring well network, and even longer to reach the Gila River, the number of re-calibrations may be as little as two or as many as three over the life of the mining operation, with the last re-calibration at or shortly after the end of mine pumping. With the model's capability of predicting mitigable changes in flow to the Gila River long in advance of the time mitigation must be implemented, there is no need for recalibration at intervals of less than three years.

3.3.2. Watson Wash Hot Well Monitoring Program

The Watson Wash Hot Well is not a natural hydrologic feature. It is a well drilled and left uncapped which flows water high in total dissolved solids on a continual basis. A rock and concrete tub presently conceals the well head and the discharge from the well head is conducted into the tub by two-inch PVC pipe. The discharge rate from the PVC pipe on February 12, 1998 was estimated at about one liter per second or 16 gpm. There is no provision for shutting the flow off at the present time, and it is not known whether all the discharge from the well passes through the PVC pipe or whether some may escape within or under the concrete tub enclosure. The well/tub, located on public lands administered by BLM, attracts bathers, has supported a population of introduced Gila Topminnow,[24] and introduces significant quantities of salts to the shallow groundwater systems downgradient from the well. Local residents portray the site as an attractive nuisance, and believe it is contaminating their shallow domestic wells (J. Korolsky, oral communication with R. MacNish, 1998).

The 2002 model projection run predicts that the maximum effect on this well occurs approximately 280 years after initiation of mine development and the pressure head in this well would be reduced about approximately 0.62 feet, due to the mine pumping (email from P. Sinton to R. MacNish, August 30, 2002). Because the pressure head in this well is not known at the present time, it cannot be determined whether or not this small reduction in pressure head would have a noticeable effect on the flow of water. Lowering the level of the discharge pipe from the well by 0.62 feet would restore the present flow rate. It should be noted that if the discharge pipe is lowered before the pressure head in the aquifer is diminished by the mine pumping, the rate of discharge of both water and its accompanying salt load would increase above present levels.

The recommendation for this site is to use a stopper plug for the 2-inch PVC discharge, fitted with a water pressure meter, to permit periodic (annual) measurement of shut-in pressure. Annual measurements of pressure head would be sufficient to determine any effects of mine pumpage. It should be noted that any reduction in pressure in the artesian zone supplying this well will reduce the amount of water and salt reaching the Gila River. Due to the impact of the uncapped artesian well on the Gila River and potable water aquifers, BLM is currently evaluating various management alternatives for the Watson Wash Hot Well. These alternatives include consideration of commercial or recreational development or closure of the artesian well to reduce water quality impacts to the Gila River. One consequence of this effort may be that the well site is plugged, at which point issues related to mine pumpage effects cease to exist.

[24] Recent surveys conducted at Watson Wash Hot Well by the AGFD and USFWS failed to detect any Gila Topminnow (BLM Safford Field Office). Two more surveys are planned to determine more conclusively that this introduced population has been extirpated. Should these surveys fail to detect Gila Topminnow the Watson Wash Hot Well will be considered unoccupied.

3.3.3. Alternate Year Fallowing Program

In order to mitigate potential impacts to the Gila River identified during impact assessment, water will be left in the Gila River system. PDSI will effect mitigation by fallowing certain farmlands that it owns in the Safford Valley. Diverted Gila River water and groundwater from wells that would have otherwise been consumed by crops on these fallowed lands will be left in the Gila River system to the benefit of downstream resources and water users. Although the full predicted impacts of pumping do not occur until approximately 450 years after mine start-up, the mitigation will be implemented within one year of Project startup.

Under the proposed Alternate Year Fallowing program, 200 acres of land[25] will be fallowed every year. To accomplish this in a manner consistent with existing agricultural practice in the valley and with applicable water law, two groups of fields totaling 200 acres each will be used. The groups of fields are located on three farms depicted in Figure 12. These farms have decreed water rights that were established in the early 1900s.

Fields within the three farms will be divided into two groups. The first group of fields is referred to here as "Alternate Year Fallow Sites 1" and the second group of fields is referred to here as "Alternate Year Fallow Site's 2". "Alternate Year Fallow Site 1" fields will be fallowed in odd-numbered years and "Alternate Year Fallow Site 2" fields fallowed in even-numbered years. In this manner, beneficial use of the surface water right associated with each farm can be demonstrated every other year, preserving the Decreed Water Right and, therefore, the benefit to the Gila River system from the Alternate Year Fallowing Program.

The fallowing program will be implemented by means of deed restrictions, which PDSI will record against each of the farms. The deed restrictions will require that 200 acres of land be fallowed every other year in perpetuity. Lands that are fallowed in a particular year will not be irrigated with either surface water or groundwater for the entire year. Deed restrictions requiring alternate year fallowing will be recorded prior to the time groundwater pumping for the project begins and will be enforceable by the United States through the COE regulatory authority granted under the CWA and the conditions of any Section 404 permit issued for this project. The deed restrictions would be removed in the event the Project does not go forward.

[25] Determining the acreage of land to be fallowed each year was based upon PDSI's desire to provide sufficient contingency in its mitigation effort to account for additional mitigation requirements that may be identified by groundwater monitoring and model recalibration efforts.

The average annual benefit to the Gila River system from the Alternate Year Fallowing program is estimated to be 480 af/yr, 331 af/yr more than the predicted maximum annual impact of proposed mine development activities to the Gila River system.[26] The proposed mitigation program provides more than three times the amount of mitigation required to offset currently predicted model impacts. If, after completion of model re-calibration, total predicted impacts to the Gila River exceed 480 af/yr, additional decreed acreage will be fallowed to offset any model predicted increases in project effects at a minimum 1:1 ratio.

The beneficial effects of the proposed Alternate Year Fallowing program are substantial. A significant portion of the predicted impacts (ephemeral storm water runoff reductions) is associated with episodic flash flood events. Conversely, the benefit to the Gila River from reduced agricultural consumptive use occurs throughout the growing season, during periods of normally reduced or intermittent flow conditions, the period of greatest potential environmental stress to riparian systems found along the Gila River. It is demonstrably clear that the fallowing program will result in a net benefit to the Gila River system when one considers the following:

- The ephemeral nature of surface water flows affected by proposed mine development and the seasonal benefits of the alternate year fallowing program,
- The 480 af/yr reduction in consumptive use compared with the maximum model predicted impacts of 149 af/yr, and
- That the maximum modeled impacts to the Gila River system do not occur for approximately 450 years and then are predicted to decrease after that point.

3.4. Water Resources Mitigation and Monitoring Reporting

Annual monitoring reports documenting the Model, Monitor, and Mitigate program will be prepared throughout the life of the Project. The annual report shall be prepared by PDSI or its contractor documenting the data collected from the water level monitoring program, and the analysis of this data in the re-calibration test. Also included in the report will be the updated actual pumpage for the year and a discussion of potential changes in mining plans that would have an impact on future pumping plans. If changes in annual pumping rates are projected to increase by more than five percent, a long-term model projection will be made to evaluate the necessity of modifying the mitigation measures. The annual monitoring report shall have an executive summary section that summarizes the report for the lay person. The annual report will be reviewed for technical adequacy by the USGS and made available to any interested party.

[26] Calculation of the annual benefit was determined by multiplying the Annual Consumptive use determined from five years of recorded agricultural activities at the farms that will be used in the Alternate Year Fallowing Program by the total acreage of land that will be fallowed each year. Therefore: 2.4 af/yr/acre*200 acres = 480 af/yr.

As all the water level and pumping data will be available from a publicly accessible database, only graphic illustrations comparing observed and model projected water levels need be shown. These reports will include all data analysis completed pursuant to the plan, and the results of any model recalibration efforts required by the Plan. Additionally, the reports will provide documentation of the Alternate Year Fallowing Program. Water Resources Mitigation monitoring reports will be included with the Habitat Mitigation and Monitoring Report submitted to the Tucson office of the COE on November 1st of each year.

3.5. STAKEHOLDERS COMMITTEE

A Stakeholder Committee will be established to present information developed through the 3M Program to those entities having a vested interest concerning potential impacts to water resources that result from development of the Project, including the benefits of the proposed mitigation efforts. The forum provided by the Stakeholders Committee will provide an opportunity for the potentially affected public to be informed of the status of ground water impacts and mitigation efforts, model status, and to provide comments in regard to the implementation of the 3M Program.

Membership on the Stakeholder Committee is voluntary and is open to interested parties. The following entities will be formally invited to attend and be standing members of the Stakeholder Committee.

- Bureau of Land Management
- United States Geologic Survey
- U.S. Army Corps of Engineers
- Bureau of Indian Affairs
- Environmental Protection Agency
- Arizona Department of Water Resources
- Arizona Department of Environmental Quality
- Gila River Indian Community
- San Carlos Apache Tribe
- Phelps Dodge
- Gila Valley Irrigation District
- Ranchers with grazing allotments in the Project area

In addition, a public notice will be published in the local Safford paper a minimum of 15 days prior to the meeting to inform other individuals/groups when the annual meeting will occur. Prior to the annual meeting, standing members of the Stakeholders Committee will be sent invitations notifying them of the upcoming meeting.

Stakeholder Committee meetings will be held annually. PDCI will be responsible for convening the meetings. PDCI, in conjunction with the USGS, will conduct the meeting presentations. Meetings may consist of two separate sessions, if necessary, one for general presentation of the annual monitoring report and a second session to be held to discuss monitoring and modeling activities with those interested in specific technical details. A preliminary agenda for the primary meeting is provided below.

- Review Project water use during the past year
- Summary of Annual Report
- Groundwater level monitoring
- Water chemistry/isotope analyses (if any)
- Comparison of model-predicted and actual groundwater levels
- Overview of model re-calibration (if any)
- Projected future water use and revised modeled impacts
- Status of mitigation program

The need for the second meeting will be determined by the Standing Members of the Stakeholders meeting.

Photo 1a. Existing burned riparian habitat north of the pasture on the Ft. Thomas site.

Photo 1b. Cleared pasture at the Ft. Thomas mitigation site.

		PHELPS DODGE SAFFORD, INC. Dos Pobres/San Juan HMMP
WestLand Resources, Inc. Engineering and Environmental Consultants 2343 E. Broadway Blvd., Suite 202 Tucson, Arizona 85719 520.206.9585 Fax 520.206.9518	Photo Sheet 1	Ft. Thomas Mitigation Site

Graphics/Jobs/201.02.../DPSJ MMP photopages | Drawn by: JJC | Reviewed by: JAT | Date: 03-19-01

Photo 2a. Sudan-grass pasture and burned riparian vegetation within habitat restoration area.

Photo 2b. Photograph of habitat enhancement area. Vegetation in this area is variously dominated by willow and small etiolated tamarisk.

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WestLand Resources, Inc. Engineering and Environmental Consultants 2343 E. Broadway Blvd., Suite 202 Tucson, Arizona 85719 520.206.9585 Fax 520.206.9518	Photo Sheet 2	Pima Mitigation Site

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Photo 3a. Existing earthen berm at east end of property. Opportunities for habitat creation exist at the toe towards the river ± 40 feet and on thelandward

Photo 3b. Looking from the east end of the property south towards the river.

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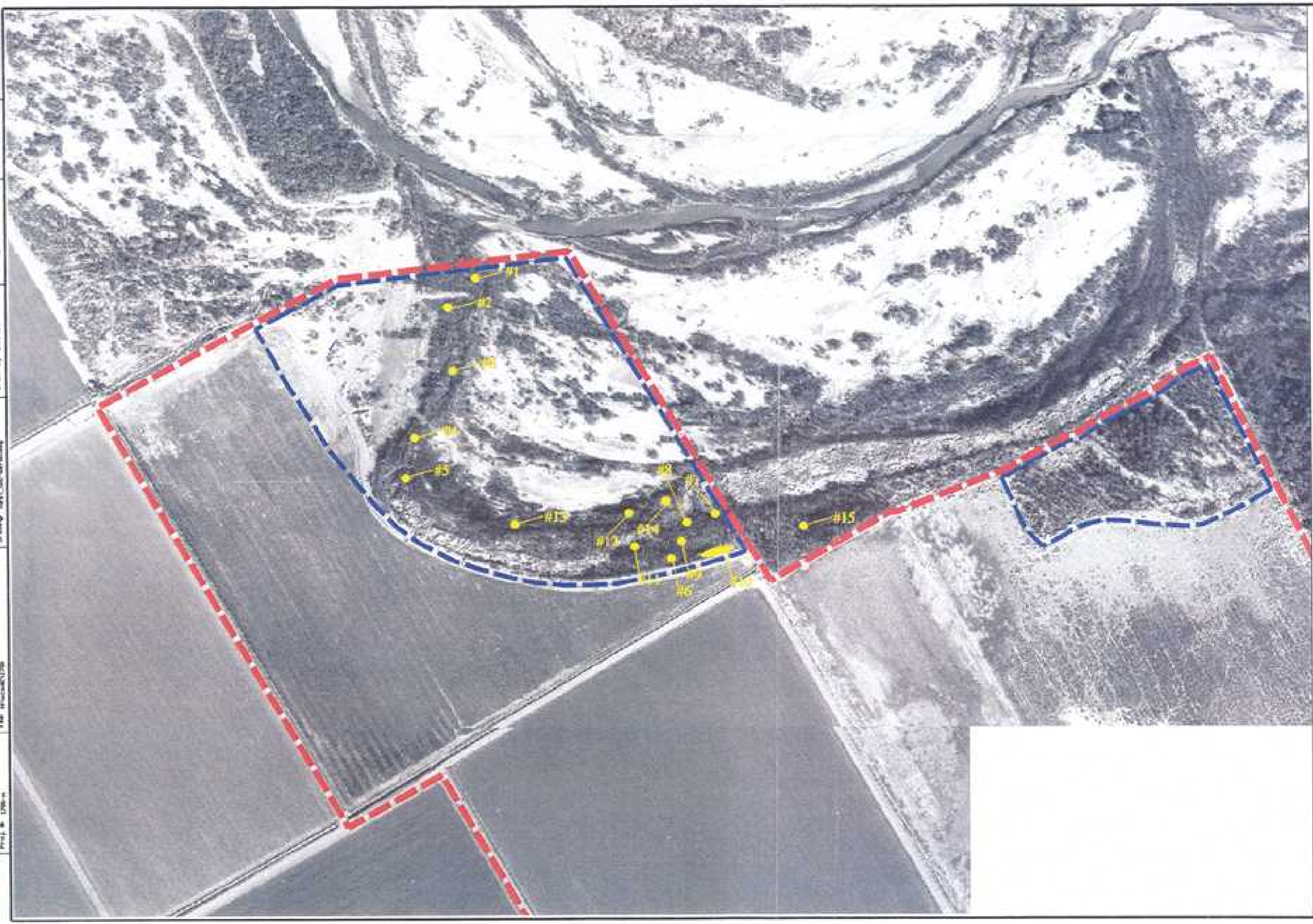
WestLand Resources, Inc. Engineering and Environmental Consultants 2343 E. Broadway Blvd., Suite 202 Tucson, Arizona 85719 520.206.9585 Fax 520.206.9518	Photo Sheet 3	Solomon Mitigation Site

Graphics/Jobs/201.02.../DPSJ MMP photopages | Drawn by: JJC | Reviewed by: JAT | Date: 03-19-01



SWF SURVEYS
PIMA MITIGATION SITE

Figure 2. Survey area showing locations of nests and fledglings.